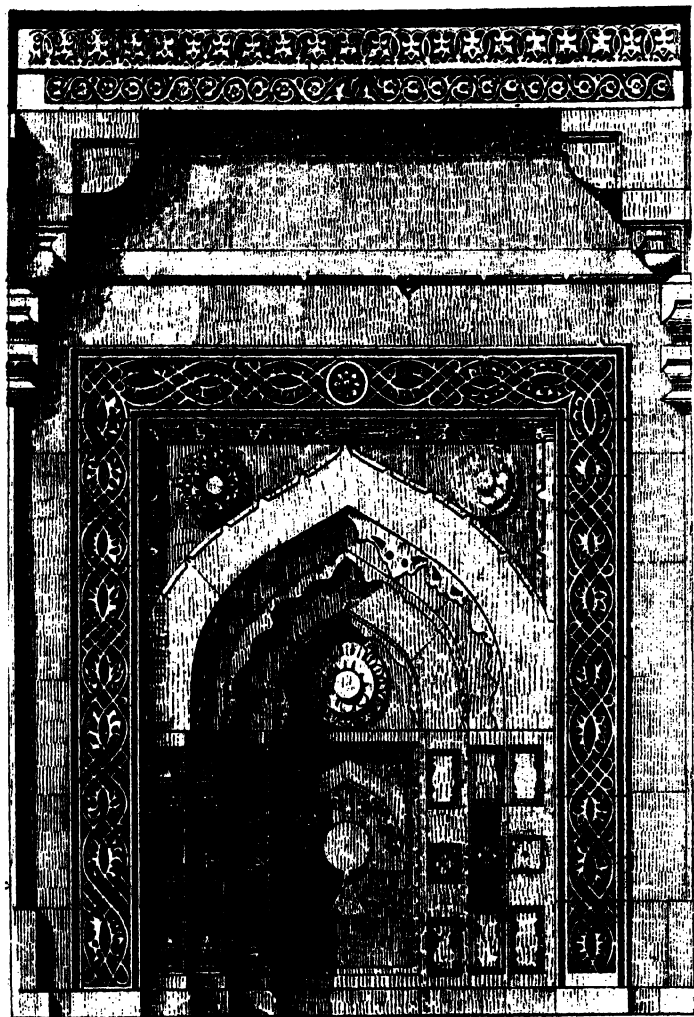




PRACTICAL NOTES
ON THE
PREPARATION OF DRAWINGS
FOR
PHOTOGRAPHIC REPRODUCTION.





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PRACTICAL NOTES
ON THE
PREPARATION OF DRAWINGS
FOR
PHOTOGRAPHIC REPRODUCTION.

*WITH A SKETCH OF THE PRINCIPAL PHOTO-MECHANICAL
PRINTING PROCESSES.*

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PREFACE.

THIS work was originally published in 1887, as a series of papers, in the *Indian Engineer*, with the object of bringing together the results of the long experience gained, in the Survey of India Department, by the writer's brother officers, in preparing maps and plans for reproduction by photo-zincography and by himself in reproducing them. It was intended specially to serve as a guide to the preparation of drawings of a technical character; and although its scope has been extended to include drawings of all kinds, and the experience gained officially has been supplemented by information gleaned from the few authors who have written on the subject, the point of view has necessarily been that of the photographer, and is technical rather than artistic. In India, unfortunately, we live quite outside the world of Western art, though not beyond its influence, and are confronted daily more and more by ever-increasing demands for speedy and cheap processes of photographic reproduction to meet administrative needs, and some guidance is necessary for those who have to prepare maps and drawings for this purpose in various departments of the empire.

The artistic aspects and technique of the different modes of drawing and painting in black and white or

colour have, however, been thoroughly well discussed in Mr. P. G. Hamerton's valuable work, "The Graphic Arts," while Mr. H. R. Robertson's little book, "The Art of Pen and Ink Drawing," contains a great deal of useful and practical information on that special branch of drawing. From both these works, and from Mr. Trueman Wood's "Modern Methods of Illustrating Books," the writer has taken the liberty of borrowing.

Pen and ink drawing has quite recently been more extensively considered and illustrated as a special art in Mr. Joseph Pennell's sumptuous volume on "Pen Drawing and Pen Draughtsmen," which the writer has only just had the opportunity of seeing. While chiefly devoted to a consideration of the style and method of various masters of the art, it contains chapters on "The Materials for Pen Drawing," "Technical Suggestions for Pen Drawing," and "The Reproduction of Pen Drawings," which are replete with good practical hints.

Photography has, without doubt, contributed very largely to the present position of pen drawing as a recognised art. It is, however, to be regretted that, owing to the demands for cheap magazine and book illustration, the tendency is for pen drawings to be reproduced by "process" blocks which can be set up and printed with the type. However useful these block processes may be as a substitute for the slower and more expensive woodcut, they impose great limitations on the draughtsman, and are but a coarse and clumsy means of reproducing delicate and finished pen-work, as many of the examples in Mr. Pennell's book serve to prove. The same may be said of photo-

lithography and photo-zincography as applied to the reproduction of maps and plans of larger size.

The only photographic processes which are really suitable for reproducing fine pen and ink work, as well as drawings in wash, are the intaglio methods of photogravure, and of these the best is the photo-etching method, founded on the photoglyphic process invented by Fox Talbot some eight-and-thirty years ago. The writer had full proof of this when lately reproducing the plates illustrating Dr. A. Führer's "Report on the Sharqi Architecture of Jaunpur," edited by Dr. James Burgess, C.I.E., and recently published as the commencement of a new series of the "Reports of the Archæological Survey of India." Several of these plates were so finely drawn in pen and ink that when reduced they could be printed in no other manner. This is shown in the specimen given as Frontispiece.

Photogravure is, in fact, the only press process which will perfectly preserve the distinctive touch of the artist and bring out the finest and palest lines with due effect. Apart from the expense, which, after all, is really very small in comparison with hand-engraving, the only hindrance to its more general adoption, at any rate for full-page plate-work, is the slowness of copperplate-printing; but this will speedily be removed by the construction of machines for the purpose. In the Paris Exhibition, 1889, Messrs. Alauzet exhibited a machine of the kind, which seemed capable of printing very good work from plates in half-tone. It is hoped, therefore, that before long means may be found of utilising this beautiful process more extensively both for line and half-tint work.

The absence of any published work treating generally on the special subject of preparing drawings of all kinds, suitable for photographic reproduction by the various photo-mechanical processes, leads the writer to hope that this little work may be found useful by those interested in the question, although he regrets that his knowledge of what is being done in this direction in Europe and America must necessarily be very imperfect.

Since its first appearance in serial form, the work has been carefully revised and added to; and the author's acknowledgments are due to Colonel H. R. Thuillier, R.E., the Surveyor General of India, who has throughout taken a friendly interest in the work, and obtained for the writer the permission of the Government of India to use official documents, and to have the plates illustrating it prepared in the Survey of India Office. He also has to thank his friends Colonels Tanner and Cowan, S.C., and Major St. G. Gore, R.E., for help and information kindly given in revision.

CALCUTTA, *January 27th*, 1890.

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THE
PREPARATION OF DRAWINGS
FOR
PHOTOGRAPHIC REPRODUCTION.

CHAPTER I.

ADVANTAGES OF PHOTOGRAPHY.

AMONG the many applications of the art of photography, one of the most valuable and practically useful is the reproduction in fac-simile of maps, plans, drawings, prints, or engravings, whether required for technical or artistic purposes, on any scale, either the same, larger, or smaller, by processes similar in effect to the ordinary methods of lithography or engraving on wood or metal, but, as a rule, much cheaper and more speedy in execution. The specific advantages to be gained by the use of photography for these purposes are :—

- (i.) Rapidity of production and multiplication, especially when employed for copying subjects containing close and intricate details. The

gain varies according to the amount of detail and the time that would be taken by a skilled draughtsman or engraver to make the copy by hand. For instance, a highly finished drawing which would take several months to lithograph or engrave, may, by the aid of photography, be copied and some hundreds of copies printed off within a few days, or even in a few hours, by the aid of the latest modern appliances of electric lighting and steam printing.

- (ii.) The perfect fidelity with which the most delicately minute and intricate details are copied. The most skilful and careful draughtsman is liable to make errors in copying, and never can attain the same accuracy of delineation, especially of minute objects, as is obtained with the camera.
- (iii.) The facility with which copies may be obtained on scales larger or smaller than the original. The extent to which this may be taken advantage of depends very much upon the object in view, as well as upon the style of the original, and the relative thickness and size of the lines and details composing it. Although the results are often disappointing for purposes of publication, owing to the unsuitability of the original subjects, this facility of enlarging or reducing the scale of drawing

or print with the most perfect accuracy and with the absence of all personal error, is one of the most important advantages of photography. Its immense superiority in this respect over the pantagraph and other methods for tracing and compiling purposes has been proved to be beyond question.

- (iv.) The comparative cheapness of the photographic methods. The relative cost of hand labour and photography is affected by several considerations, *e.g.*, the nature of the subject, the process employed, the number of copies to be made, and the pay of the photographers as compared with that of draughtsmen. In most cases it will be found that when it is really an advantage to employ photography in reproducing drawings, &c., for any particular purpose, the cost will be far less than it would be if done by hand.

These facilities have consequently caused photography to be largely availed of by the Government of India, as well as by civilised governments all over the world, for the reproduction of maps, plans, diagrams, and technical drawings required for administrative purposes, whether fiscal, military, geographical, engineering, scientific, or industrial.

In India especially, where skilled lithographic draughtsmen and copper-plate engravers are scarce, and hand-work in any case progresses slowly, the em-

ployment of photography has enabled maps of the various topographical, revenue, and cadastral surveys to be published *pari passu* with the progress of the surveys, and an immense number of other valuable plans and drawings have been reproduced for other departments which could not possibly have been accomplished by lithography or engraving alone.

Besides their use for public and administrative purposes, these applications of photography are largely employed all over the world by engineers, architects, and manufacturers for reproducing their technical and working plans and drawings, as well as by publishers for book illustrations, and also for producing fac-similes of ancient and rare works. In book illustration photography has worked an entire revolution within the last few years. Lithography has almost disappeared, except for colour work, maps, and scientific drawings, while wood engraving is fast being superseded for all ordinary purposes by "process" blocks.

For the reproduction of the higher classes of artistic work, such as copies of paintings and other works of art, the various processes of heliogravure and photocollotype have very largely taken the place of hand engraving on steel or copper plates. Copies of the best examples of ancient and modern art, instead of being confined to the shelves and portfolios of the few, are now brought within easy reach of the million.

Although photography is undoubtedly capable of

taking the place, to a great extent, of lithography and hand engraving, it must not be supposed that nothing more is required than to set up the drawing or picture to be copied in front of a camera, expose and develop a plate, and print off by one of the many photo-mechanical methods. By such a procedure a copy would no doubt be obtained, but it would almost certainly be worthless for practical purposes.

To obtain the best results from photographic reproduction, certain essential conditions must be fulfilled, both in the preparation of the original drawing to be copied and in the photographic and photo-mechanical printing processes, which offer peculiar difficulties, only to be overcome by great skill and experience on the part of the photographer and the photo-lithographer or photo-engraver.

The extension of the use of photographic reproduction has been greatly impeded by the difficulty of getting draughtsmen to fully understand the requirements of the different photographic and photo-mechanical methods: that outline drawings must be neatly drawn in good black ink on pure white paper, so that every line may be reproduced of its proper strength, whether the drawing be copied to scale or reduced; and that drawings in wash have to be even still more carefully prepared with reference to the difficulties of reproducing colours by photography.

In a paper read before the Asiatic Society of Bengal in 1878, the writer remarked:—

“It matters little how roughly drawn or highly coloured an original drawing or map may be, if it is intended to lithograph or engrave it, because a skilled lithographer or engraver can easily put it into proper and conventional form; but when such a drawing is handed to the photographer he can only produce a facsimile of it with all its deficiencies—the coloured details hidden under a black mass of shade, the finer parts, perhaps, wanting altogether, the writing rough and broken, or so small as to be almost invisible, besides other defects caused by the unsuitableness of the drawing for reproduction by photography; and these defects are liable to be unduly attributed to the process.

“These difficulties were felt in all their force when it was first determined to introduce photo-zincography for the publication of the maps of the Imperial Indian Surveys, because till that time these maps had been drawn in a very delicate, highly finished style, with many of the details on them coloured and the hill features shown by brush shading. It was soon seen that an entire change of style was necessary, and that the original maps prepared specially for photographic reproduction must be drawn in pen and ink lines alone, without colour or brush-shading. It was some time before the desired results were obtained, but after several years’ experience a high degree of excellence has been attained in the preparation of original maps suitable for photographic reproduction, and now

all maps of the above surveys, and most of the miscellaneous maps and drawings received from other departments, are drawn with this object.

“The change of style has been regretted by some as spoiling the beauty and finish of the maps, and the want of colour certainly has some drawbacks, but there can be no doubt that the necessity for drawing the original maps so that they may be fit for immediate publication has effected here, as it has also been found to do wherever photo-zincography or photo-lithography has been introduced, an immense improvement in the style of drawing of the manuscript maps as well as in the accurate delineation of the ground. The photo-zincographed copies, as a rule, appear somewhat coarse and rough when compared with good lithographs or engravings, but they possess the great advantage of being produced quickly and cheaply; while, being absolute fac-similes of the original maps submitted by the surveyors, they are entirely free from the errors which even the most careful draughtsman is liable to make when copying by hand, and they faithfully preserve the appearance and character of the ground exactly as delineated by the surveyor.”

Since the above was written, the use of photography for reproduction has been largely extended; but it must, however, be confessed that, owing to the necessity for drawings being made as open as possible, and with no more lines than are absolutely required,

the general result has been to lower, to a very great extent, the standard of artistic excellence and finish in all classes of subjects, and it is a question in some cases whether this loss is altogether repaid by the gain in accuracy, cheapness, and rapidity of production. However, as improvements are introduced into the working of the processes, which after all are quite novel, and their requirements are better known, the artistic qualities of the results will no doubt improve. To this end the draughtsman or artist must work in unison with the photographer in the same way as he has done with the engraver or lithographer, bearing in mind that the more mechanical procedure of photography allows him far less latitude in the means of producing artistic effect, and that he must adhere to fixed rules and principles often opposed to his ordinary ways of working.

In this work we propose to point out the principles upon which drawings should be prepared for reproduction by the various methods of photographic and photo-mechanical printing.

Drawings for reproduction by photography may be divided into two main classes:—

- (i.) Those in which the effect is produced by means of a pen, brush, lead-pencil, or chalk, in distinct lines or dots, all of the same intensity of colour, but varying in thickness and distance apart, whether in outline or shaded. Such drawings may be reproduced

and printed by photographic methods analogous to lithography, wood-engraving, and line-engraving, or etching in intaglio on copper or steel plates, *viz.*, photo-lithography or photo-zincography, photo-collotype, phototypography, and photo-engraving, as well as by all the ordinary methods of purely photographic printing.

- (ii.) Those in which the effect is produced by means of a brush or stump, in continuous washes or shades of colour of varying intensity, or by a combination of line and wash. Such drawings may also be reproduced by the same methods as the last, but special arrangements have to be made by the photographer for the more or less complete breaking up of the continuous gradation of tint into fine dots or points. There is, however, another photographic process, the Woodbury-type, which, within certain limits of size, is specially suitable for the reproduction of subjects in half-tone, because there is not the same necessity for breaking up gradation of shades and forming a "grain." Both it and the photo-collotype processes, however, have the defect of imperfectly rendering the pure white ground, especially if of comparatively large area.

Shaded drawings require far more skill and care on

the part of the photographer and photo-mechanical printer than line drawings do, and the latter style is more suitable for maps, plans, and technical drawings, especially if of large size.

Besides drawings especially prepared for photographic reproduction, all ordinary prints and engravings can be reproduced in the same way as line drawings, provided the paper they are printed on is white or only slightly tinted. Prints on dark tinted papers, coloured drawings, and paintings in oil or water colour, can also be reproduced by the same processes as washed drawings in monochrome, but allowance must be made for the fact that unless special precautions are taken by the use of orthochromatic plates, the effect of coloured objects, as seen by the eye, is liable to be quite changed when reproduced by photography. Thus, although all tints of yellow, from the darkest to the palest, give the impression of light to the eye, they will come out dark in the photograph. On the other hand, shadows containing blue will appear much lighter in the photograph than they do in the original picture. Greens and reds also reproduce darker than they appear in pictures. In this way the whole effect of a picture may be changed, shadows reproducing as lights and lights as shadows. Until recently this was a great bar to the employment of photography for copying pictures in oils or water-colours, or in fact coloured drawings of any kind. It is now, however, possible, by staining the photographic plate, whether collodion or gelatine, with

certain dyes, and by the use of suitably coloured screens, to alter the photographic effect of the luminous rays on the sensitive surface, so that the power of the yellow rays is increased while that of the blue rays is lessened, and in this manner a much more truthful representation of coloured objects can be obtained than was formerly possible.

CHAPTER II.

PHOTOGRAPHIC AND PHOTO-MECHANICAL PROCESSES.

It would be quite outside the object of this work to enter into details of the various photographic and photo-mechanical processes, but a brief outline of their nature and principles will be of use in understanding the special requirements that have to be fulfilled by the draughtsman in order to utilise them to the best advantage.

When only a few copies of a subject are required, it is usual to produce the photographic prints by ordinary silver printing, or, in the case of large technical drawings, by the much cheaper methods dependent on the use of the salts of iron, such as the "cyanotype," in which the prints are blue, or the "ferrogallate," in which they are black. The simple carbon processes, in which paper is prepared with a coating of gum or gelatine, mixed with black or other pigment, and sensitised in a bath of bichromate of potash, are also very suitable for line work. Whatever process is used the whole photographic operations must be repeated for

each print, and rapidity of printing is dependent on the state of the light.

When, however, a larger number of copies is required, for publication or other purposes, recourse must be had to the photo-mechanical processes already noticed, which have the advantage that once a suitable photographic image has been obtained on the printing surface any number of impressions may be taken from it by the ordinary methods of lithographic, letterpress, or copperplate printing. The photographic image may be transferred to stone or zinc to be printed like any ordinary lithograph, or developed on a zinc or copper plate and converted, by means of biting with acids or by electrotyping, either into a relief block suitable for printing with type or into a plate in intaglio capable of being printed in the copperplate press. Or the more essentially photo-mechanical methods of photo-collotype or Woodbury-type may be employed. By all these methods the printing may be performed by night or day, quite independently of the agency of light, and no further chemical or photographic manipulations are required.

PHOTO-LITHOGRAPHY.

The simplest and most generally useful of these processes is *photo-lithography*, or the analogous *photo-zinco-graphy*, the principal difference between the latter and the former being merely the substitution of a thin smooth

plate of grained zinc for the thick heavy lithographic stone. For subjects of large size zinc is certainly the most suitable, and offers in other respects all the advantages of stone, but the latter being better known is generally preferred for ordinary work of moderate size, and is undoubtedly of a better colour for drawing upon.

In ordinary lithography, or zincography, the image may be produced on the stone or zinc either by *transfer* from a drawing on paper with the solution of resinous soap known as "autographic ink," or by *drawing direct* on the stone with a similar ink or crayon. In photo-lithography, also, there are two corresponding methods of obtaining the photographic image, either by transfer from a photographic print in fatty ink, or by impressing the image direct on the stone. The transfer method, being the most convenient, is the one in general use.

Tough paper is coated with a mixture of gelatine and bichromate of potash, and when dry exposed to light under a photographic negative. The parts of the yellow coating acted on by the light passing through the transparent parts of the negative turn brown and lose their solubility. If the exposed print be now evenly coated all over with a greasy lithographic transfer ink and then washed with a soft sponge and warm water, the yellow and still soluble parts of the picture will wash away, carrying the ink with them and leaving the ground quite white and clear, while

the lines, being insoluble, will retain the ink and form an image in black, the exact fac-simile of the original, and suitable for transfer to stone or zinc in the same manner as an ordinary lithographic transfer drawing. Instead of gelatine, gum, albumen, or starch may be used for preparing the paper, but gelatine is most convenient.

A great advantage of the transfer method is that a large map or drawing may be photographed in several sections and the transfers can be joined up so as to form large sheets.

In the direct processes the smooth surface of a lithographic stone or a finely grained zinc plate is coated with a mixture of albumen or gum with bichromate of potash, or with a thin varnish of asphaltum dissolved in turpentine or benzole. The negative, which must be *reversed*, is laid in close contact with the surface and exposed to light. In either case the exposed parts of the sensitive coating forming the image become insoluble in the usual solvents, and apt to take up printing ink, while the ground becomes quite clear and ready to receive the coating of gum and acid which protects it from the printing ink. The direct processes are, as a rule, restricted in size to a single negative.

It is important to note that whether the photographic image is obtained either by transfer or directly on stone or zinc, it receives an even coating of printing ink from the rollers passed over it, and therefore all

the lines or dots composing it are equally black. In weak parts of the original drawing, where the lines have not been strong enough to reproduce clearly on the negative, the light will be unable to completely penetrate the sensitive coating of bichromated gelatine or asphaltum, and consequently, the weak lines being only on the surface, will be liable to wash away entirely or partially, and give a weak and rotten effect. The draughtsman, bearing this in mind, should be careful to execute his drawing in strong black ink of one intensity only, obtaining gradation of shade by variation in the thickness of the lines.

The photo-lithographic processes have been used for the reproduction of brush-shaded maps and architectural and engineering drawings, but even with care and skill the results are not altogether satisfactory. Recently, however, great improvements have been made in processes of this kind specially suitable for such purposes, and for half-tone work generally.

They may also be used for copying prints or engravings of all kinds on the same, larger, or smaller scales, but the finest class of engravings, and even many lithographs, are generally more or less unsuitable for the purpose. The best results are obtained from original drawings in line or dot alone, specially prepared to suit the requirements of the processes in strict accordance with the rules given hereafter.

PHOTO-TYPOGRAPHY.

The processes just described are best suited for subjects of large size to be printed in separate sheets ; for small or moderately sized subjects, intended to be set up and printed with type for book illustration, in the same way as woodcuts, stereotyped or electrotyped blocks, the photo-typographic processes are exceedingly useful, and offer great advantages over wood-engraving in the rapidity with which the blocks may be made and printed off in large numbers. Within the last few years these processes have been very successfully adapted to the reproduction of half-tone subjects of all kinds, whether photographs taken from nature or copies of pictures or drawings, and are largely used in Europe and America for work of this kind.

In the photo-typographical processes most commonly used, the photographic image is obtained upon a zinc plate, either by transfer or directly by contact printing, in precisely the same manner as for photo-zincography, but the white parts of the picture have to be bitten away with acid in varying depths according to the closeness of the lines together, leaving the lines forming the image standing in relief and all of an equal height, so as to give an even impression when the flat platen of the printing-press is applied.

The effect is produced by repeated bitings, sometimes as many as seventeen or eighteen, followed by careful inking in, heating, and powdering with resin, and the

operations require considerable skill. This method was first introduced by Gillot, of Paris, and is known also by the terms "gillotype" and "gillotage," or, more commonly, "process."

In other methods of photo-typography, advantage is taken of the property possessed by a sensitive film of gelatine and bichromate of potash, after exposure to light under a photographic negative, of absorbing water and swelling up in the parts not exposed to light, while those protected from the light do not absorb water or swell. If a stereotype cast or electrotype be taken from such a mould an image in relief is obtained which, when properly mounted, forms the printing block.

The following method is a typical one:—A glass plate or other suitable surface is coated with a mixture of gelatine and bichromate of potash, and when dry exposed to light under a negative. After this, it is immersed in cold water till the parts unaltered by the light, which represent the whites of the original drawing, swell up to the required height, leaving the lines quite sunk. The plate is then removed from the water, and, the superfluous moisture having been carefully blotted off, is ready to have a cast made from it.

This may be done in two ways: first, by metalising the gelatine surface, either by brushing it over with plumbago or bronze powder, or by reducing metallic silver upon it by applying a solution of nitrate

of silver followed by treatment with a solution of pyrogallic acid, sulphate of iron, or phosphorus in bisulphide of carbon. The gelatine relief is then placed in the electrotyping apparatus and receives a thin deposit of copper in the usual way. The thin copper electrotype is backed up with type-metal, planed, and mounted on a wooden block so as to be of the height of type.

This method gives the finest results, but takes time.

The second method is to take a cast of the gelatine relief in type-metal. A cast in plaster, wax, &c., must first be taken from the gelatine, a second cast in plaster is made from this, and then stereotyped in the usual manner. This method is quicker than the last, but the results are coarser.

In these processes also, in order to produce the best effects from line work, the lines of the original drawing must all be equally black, and the same precautions taken as for photo-lithography.

PHOTO-ENGRAVING.

For fine map work or other finished and delicate drawings in line, as well as for the higher classes of half-tone work—in short, for all such work as would usually be engraved by hand—the various processes of photographic engraving are very suitable. They are infinitely cheaper and quicker than hand engraving, and have the same advantages, *viz.*, that the

engraved plate once obtained serves for the impression of a large number of uniformly good copies with very little wear, if it is properly protected by a coating of iron, and further it may be indefinitely multiplied by electrotyping: while by making transfers to stone or zinc the printing of large numbers of copies may be vastly accelerated and indefinitely repeated with little or no wear of the original copperplates.

There are two principal methods by which an engraved plate may be obtained by means of photography—(i.) by biting out or etching the photographic image with acids or other chemical solutions: (ii.) by obtaining a photographic image in relief upon a suitable surface as a matrix upon which copper can be deposited by electricity to form a printing-plate.

A large number of processes based on these principles have been proposed from time to time, but the following methods are now, perhaps, the most largely used, and may be taken as typical.

A finely polished engraver's copperplate having been well cleaned and prepared, as for engraving, is placed in a box containing a quantity of finely powdered bitumen or other resin, so that the resinous dust falls evenly over the surface of the plate, forming what is termed a "grain." The particles of bitumen are fixed to the plate by heat, or by subjecting it to the fumes of benzole or oil of lavender.

A negative photographic image in gelatine is then developed on the grained copper-plate by the ordinary

operations of the autotype or pigment-printing process, using a reversed transparency instead of a negative, as in ordinary carbon printing.

If a line subject, the whole image should appear clearly in almost bare copper upon a dark ground covered with a thick coating of coloured gelatine. If a half-tone subject, the deepest shadows of the resulting picture should similarly appear as almost bare copper, while the highest lights will have a thick and opaque coating of gelatine, the intermediate tones being represented by a greater or less amount of gelatine according as they increase in depth of shade from light to dark. The edges and back being varnished, the plate is etched with a very strong solution of perchloride of iron. This at once attacks and dissolves the copper in the bare parts and at the same time hardens the gelatine, though gradually permeating it and attacking the copper beneath to varying depths corresponding to the thickness of the gelatine film. Thus, the deepest shadows, where there is little or no gelatine, are bitten to a considerable depth, the intermediate shades are bitten less and less as they gradually become lighter, while in the high lights, where the gelatine is thickest, the copper should not be bitten at all, but preserve its original bright polish. For line-work one etching is sufficient, but for half-tone work it is better to repeat the etching three or four times, with weaker solutions each time. In any case the biting takes only a few minutes, and after the

removal of the gelatine and varnish the plate is ready to be printed from.

This method has the advantage of being a very rapid one, and the whole operation of producing a plate, which might take an engraver months to engrave, can be completed in a few hours and at a very small cost for materials. With suitable subjects great richness of tone and effect is produced, and it is most marvellous to see the perfection with which minute differences of delicate shading are reproduced. The process is adapted for the reproduction of all classes of subjects, but is, perhaps, more specially valuable for half-tone work, and particularly for the reproduction of shaded or monochrome drawings.

In another variety of the photo-etching processes, chiefly suitable for the reproduction of line work, the copper plate is coated with a solution of bitumen or asphaltum, in benzole or turpentine, and exposed to light under a positive cliché. After sufficient exposure the plate is washed with turpentine, which dissolves the soluble bitumen in the lines of the picture, leaving the ground protected by the insoluble bitumen, which takes the place of the ordinary etching ground. The plate can then be etched with acid, &c., exactly in the same way as an etching by hand.

In what may be termed the photo-electrotype methods, a raised photographic matrix is prepared by developing on a polished and silvered copperplate a positive image in gelatine, which is obtained from

a *reversed* negative by the ordinary operations of the autotype or pigment-printing process. If a line subject, the lines forming the image will be seen to stand up in sensible relief on the polished copper, which should itself be quite free from gelatine and preserve its polish. The gelatine-relief being dried and hardened, is black-leaded, and is then ready for the electrotyping battery. The gelatine-relief may also be developed upon glass plates prepared with a thin substratum of gelatine hardened with bichromate of potash, and is rendered conductive by reducing silver on the whole surface.

If the subject is a half-tone one, the relief will vary in thickness according to the depth of tint, *i.e.*, the darkest shadows will be most raised, the intermediate shades will gradually decrease in thickness, and the highest lights will be bare copper—the exact converse of the photo-etching process. It is, however, essentially necessary for this class of subjects that the surface of the gelatine-relief should be roughened, so that the surface of the copper intaglio may also be rough, in order to hold the printing-ink in due proportion. This may be done either by mixing some fine gritty material, such as plumbago, powdered glass, manganese, &c., with the coloured gelatine in preparing the sensitive tissue, or by applying the gritty material to the surface of the gelatine-relief while wet, and removing it again when dry. Sand, glass, or emery powder that have been coated with stearine or wax,

to prevent them from sticking to the gelatine, answer the purpose admirably. The gritty particles sink into the gelatine surface as it dries and impress it all over with a number of little pits which are deeper in the shadows, where there is most gelatine, than in the lights, where there is less. And this is just the effect required. The gritty powder is brushed off when the plate is thoroughly dry, or, if necessary, may be washed off with cold water, and when again dry the plate is black-leaded and is ready for the battery.

The operation of electrotyping takes about three weeks to obtain a plate of sufficient thickness for printing. The photo-electrotype processes are therefore much slower than the photo-etching, but they are, perhaps, in some ways more certain, and are specially suitable for fine line work, such as reproduction of maps or highly detailed architectural drawings. Some very delicate drawings of the latter class, executed under the superintendence of Dr. J. Burgess for the Archæological Survey of Western India, have lately been reduced and printed in the Survey of India Office by this process with much greater perfection than if they had been photo-zincographed.

It may be remarked that there is one important point in which these processes of photo-engraving have a great advantage over photo-zincography or photo-typography—especially in reproducing drawings in line—and that is, the greater facility for bringing out faint lines. In the latter processes, as

has already been noticed, an even coating of ink is applied to the stone or printing block for each impression, and all parts of the image are equally black. In the photo-engraving processes, the lines or depressions of the intaglio copperplate, being of varying thickness, receive more or less ink according to their depth, and consequently the relative strength of the lines can be more truly preserved and more artistic effects produced.

Before printing from copperplates engraved by photography, the surface of the plate must be protected with a coating of iron, by the process known as *acierage*, in order to harden it and allow of a larger number of copies being printed than would otherwise be possible.

When a large number of copies is required, and the ordinary copperplate printing process would take too long, transfers from the engraved plates can be made to stone or zinc and printed by machine or hand power. For half-tone transfers to stone the writer's "waxed sand" process of photo-electrotype has been found specially useful.

PHOTO-COLLOTYPE.

The photo-collotype processes (so called from the Greek *kolla*, glue) differ from the preceding processes, as well as from ordinary printing methods, in the fact that the printing surface is a moist film of gelatine,

parts of which, corresponding to the photographic image, have been rendered more or less unabsorbent of water and non-repellent of printing ink, according to the amount of the action of light upon them. The film of gelatine may be attached to plates of metal or glass—usually the latter—and the printing is best conducted by vertical pressure in an ordinary printing-press, or by machines specially constructed for the purpose.

A thick glass plate, having one side finely ground with sand, is coated evenly, on the ground side, with a mixture of gelatine, albumen, and bichromate of potash; a small quantity of some hardening agent, such as chrome alum or a solution of resinous gums, being added to harden the gelatine coating and render it capable of standing the wear and tear of printing. The coating being dry, the plate is exposed to light under a reversed negative, the image being visible in "brown on a yellow ground. After this it is customary to expose the under-side of the gelatine film to the light for a few minutes, through the back of the glass, in order to insure the adhesion of the film to the glass, and also to harden it and prevent it from swelling unevenly below the image. The plate is then soaked in water to remove the yellow bichromate, and is ready for printing. The surface moisture being removed, a lithographic roller, charged with printing ink, is passed over the surface. The ink will be found to attach itself only to the parts acted on by light,

and in exact proportion to the extent of that action, *i.e.*, the deep shadows, represented by the most transparent parts of the negative, being quite hard and unabsorbent of water, will take a full supply of ink; the darker middle tints will take less; the lighter middle tints very little, while the ground of the picture and the high lights, which have been entirely protected from the light, should retain their full absorbency of water, and take no ink at all, though there is generally a slight tint all over, caused by the surface of the plate being finely granulated.

It will be seen that in some respects the photocollotype processes resemble lithography, but there is a very important difference between them. Whereas the lithographic stone receives a like quantity of ink in all parts of the image, and is incapable of producing a true and continuous gradation of shade, the moist gelatine film possesses the valuable property, not possessed by the stone, of receiving a greater or less amount of ink in different parts of the image, in exact proportion to the intensity of the action of the light upon them, and is thus capable of reproducing the most delicate gradations of shade almost as perfectly as they are shown in an ordinary silver-print.

Consequently these processes are suitable for the cheap and speedy reproduction of all classes of subjects, such as photographs from nature, brush-shaded and coloured maps, MS. records, drawings and paintings of all kinds. For line subjects also photo-collo-

type surpasses most of the known processes of photo-engraving, photo-zincography, or photo-lithography in the delicacy, sharpness, and clearness with which the finest lines can be reproduced. Owing to there being no intermediate process of transfer, with its attendant washings and pressings, and the plate being printed by vertical pressure, the reproduced copies are absolutely true to scale.

The process has the further advantage that the prints do not require mounting, and this makes it very suitable for book illustration, for which, indeed, it is now being largely used. It is especially valuable for illustrations of a scientific character in cases where otherwise only the highest class of lithography or engraving would be applicable at an enormously increased expense.

The prints produced by photo-collotype are usually printed with a purple ink, to resemble ordinary silver-print photographs, which they do very closely, especially if varnished. They may, however, be printed in any desired colour, as, for instance, in grey, to imitate lead-pencil drawings, or in red, for drawings or engravings in red chalk. The process also lends itself very well to colour-printing, a separate plate being prepared for each colour, as in chromo-lithography. Very excellent effects may also be produced by printing a photo-collotype picture upon a coloured basis produced by chromo-lithography or on gold or silver grounds.

Owing, however, to the very delicate nature of the gelatine printing surface, it is almost impossible to make corrections on the plates; the surface is easily worn or damaged; as a rule the plates will only yield a comparatively small number of copies, and there are sundry other difficulties to be met with in the practical working of the photo-collotype methods which have militated against their extensive adoption for the reproduction of maps or other subjects requiring alterations. The great improvements that have recently been made in photo-typography and photo-engraving, as applied to line and half-tone subjects, will further tend to their disuse.

WOODBURY-TYPE.

As already noticed, the drawback to the production of photographic prints with continuous gradation of shade, by either photo-lithography or photo-engraving, is the necessity for breaking up the continuity of gradation by a more or less marked "grain," and even in the photo-collotype processes a very fine but distinct grain is an essential for a good half-tone plate.

By a very ingenious process, invented in 1864, and called Woodbury-type, from the name of the inventor, Mr. Walter Woodbury succeeded in solving the problem of producing prints without grain in another way, and by a mode of operation analogous to "Nature-printing," has been able to produce absolutely permanent prints

with such perfect photographic gradation, combined with the most exquisite transparent delicacy and richness of tone, that none but the initiated would know that they were not ordinary silver-prints.

A tissue is first made by coating a tough film of collodion with a moderately thick even layer of gelatine and bichromate of potash, slightly coloured in order to see the progress of the development. When dry, the tissue is laid with the collodion side next to the negative film, and exposed to light proceeding from one direction only, in order to prevent diffused rays acting through the thick gelatine coating and so blurring the image. This tissue of gelatine and collodion is then temporarily attached to a glass plate and treated with hot water, very much in the same way as in the pigment-printing process. The whole of the gelatine upon which the light has not acted, and which therefore remains soluble, is dissolved away, leaving an image in relief, the highest parts of which represent the deepest shadows of the picture, while the parts intervening, down to the lowest, represent the intermediate gradations between the deepest shadows and the highest lights.

When dry, the gelatine composing this image will be quite hard, and capable of resisting the heavy pressure required to indent it into soft metal without itself being injured.

The tissue bearing the image having been stripped from the temporary support, is laid face downwards on

a sheet or block of lead or type-metal, about one-third of an inch thick, between two finely-surfaced steel plates, and submitted to the pressure of a very powerful hydraulic press. The prominent parts of the relief are thus forced into the soft metal and produce a mould, the deeper parts of which represent the shades and the shallower the lights of the picture. As the relief obtained from gelatine and bichromate of potash alone will impart to this mould a smooth surface without grain, such plates could not be printed with printers' ink, like a copperplate engraving, even were the metal hard enough to permit of it. Mr. Woodbury, therefore, used a semi-transparent ink consisting of gelatine coloured with any suitable pigment.

The leaden plate or mould is laid in a special press of peculiar construction and slightly greased. A small quantity of the coloured gelatine having been poured in a liquid state into the middle of the mould, a piece of specially prepared hard-surfaced paper is laid above it and pressed strongly down, so as to force the ink thoroughly into the depressions all over the plate and squeeze out all the ink between the surface of the metal and the paper in the parts forming the highest lights of the picture. The gelatinous ink is allowed a short time to "set" and attach itself to the paper; the latter is then removed, and brings with it a perfect impression of the picture in coloured gelatine, of different thicknesses corresponding in intensity and gradation of shade to the depth in different parts of

the plate. The print has now only to be "fixed" in a solution of alum, and when dry is perfectly permanent and ready to be trimmed and mounted.

The rate of impression is about the same as of ordinary copperplate printing, and may be carried on quite independently of light. If very large numbers are required of a single subject, it is easy to produce as many printing-plates as may be required from the original gelatine relief, which may afterwards be put away and kept indefinitely. A number of the printing presses are usually arranged on a circular revolving table, so that one attendant can fill the moulds in succession, and remove the prints, the gelatine being "set" by the time the press has completed the circuit. The cost of printing is exceedingly small, and prints are produced in large numbers at a marvellously cheap rate. As the process requires special mechanical appliances and apparatus, it has generally been worked on the large scale by public companies.

The Woodbury-type is unfortunately not well adapted for the reproduction of drawings in line, plans or maps, because it has been found very difficult to produce impressions of large dimensions. Owing also to the peculiar method of printing by squeezing out the gelatinous ink, it is almost impossible to obtain the clear black lines and pure white ground so indispensable in an outline drawing. The prints also have to be mounted, which is an objection. However, in special cases, where the work is within the capabilities

of the process, it will be found valuable, because it possesses the great advantage for the reproduction of half-tone subjects that the printing of an almost indefinite number of copies can be carried on with as perfect certainty as in ordinary lithography or engraving, while in beauty, transparency, and delicacy of gradation, the Woodbury-type prints are undoubtedly superior to collotypes and most other photo-mechanical prints when resemblance to ordinary silver-print photographs is desired.

The process has recently been very much simplified by the inventor by the substitution of gelatine moulds coated with tinfoil for the leaden moulds. This modification is known as Stannotype.

From the previous sketch of the photo-mechanical processes, it will be seen that there is now a wide choice of methods of reproducing and printing in considerable numbers all kinds of line and shaded or coloured drawings or photographs from nature, and they may be briefly recapitulated, with special reference to their adaptability for the purposes of the surveyor, engineer, or architect:—

- (i.) *Photo-lithography* and *photo-zincography*—perhaps the most generally useful processes, specially suitable for the speedy reproduction of large maps, plans and drawings in line, or for all similar subjects that would ordinarily be lithographed or zincographed. Shaded drawings or photographs from nature may be

reproduced, but not altogether successfully. An important advantage of these processes is that corrections may be carried out on the stone or zinc to an almost unlimited extent.

- (ii.) *Photo-typography* — or block processes, for the reproduction of drawings and diagrams to be printed in the printing-press for full-page book, magazine, or newspaper illustration, or to be set up, in the same way as woodcuts, with type. The best and most certain results are obtainable from special line-drawings in black and white for the same class of subjects as would ordinarily be engraved on wood. The process is also applicable by special methods to the reproduction of shaded or coloured drawings and photographs from nature ; but great care has to be exercised in the printing of these delicate subjects. The printing blocks admit of erasures, but detail cannot be added. Lettering may be added when the subject permits of the block being cut to admit type.
- (iii.) *Photo-engraving* or *heliogravure*—suitable for reproducing the finer classes of maps, architectural drawings, or drawings of instruments or machines, such as would ordinarily be engraved on copperplates. Shaded or coloured drawings and photographs from nature can also be reproduced very satisfactorily.

The printing must be done by hand in the copperplate printing-press, which is slow as compared even with hand-printing by lithography or letterpress; the plates will, however, yield a very large number of equally good impressions, and with proper precautions in *acierage*, &c., are very little worn in the printing. If greater rapidity in the printing is required, transfers may be made to stone or zinc and printed by hand or machine, but the impressions will not be so good as from the plates themselves. The photo-engraved copperplates may have details or lettering taken out or added by hand, or may be touched up with the graver, dry point, or roulette, and, in fact, treated in all respects with regard to touching up and corrections in the same way as ordinary hand-engraved plates. The plates can be multiplied to any extent by electrotyping.

- (iv.) *Photo-collotype*—also suitable for the same classes of fine line or half-tone subjects as photo-engraving. Specially suitable where the effect of an ordinary silver-print is required. The printing from the gelatine plates requires special care, and is almost as slow as copperplate printing. No corrections or additions can be made on the tender gelatine printing surface; and, as a rule, all lettering

for half-tone or other subjects, which cannot be printed at the same time as the photographic image, has to be printed separately from stone or type on to the photographic impressions.

- (v.) *Woodbury-type* or *Stannotype*—only suitable for the reproduction of coloured or shaded drawings or photographs from nature without large white spaces, also for portraits. The size is, as a rule, limited to 10" × 8". Corrections cannot be made, and the prints must be mounted. Best adapted of all photo-mechanical processes for reproducing photographs to resemble silver-prints.

CHAPTER III.

PREPARATION OF DRAWINGS IN LINE.

WE may now turn to the practical consideration of the special precautions to be taken in making drawings for reproduction by these various methods of photo-mechanical printing. Whether the original drawing be in line alone or in wash, or whatever the method of reproduction, the whole success of the result must mainly depend upon its perfection and suitability for reproduction by the process decided upon, and therefore too much care and trouble cannot be expended upon it.

We shall commence with drawings *in line* for reproduction by photo-lithography, photo-zincography, or photo-typography, because such drawings are more specially suitable for maps, plans, architectural and machine drawings, geometrical figures, and all kinds of diagrams and other subjects which do not require colour, and can be effectively represented in black and white by pen-and-ink drawing. They also demand the most special care in keeping the lines of an even blackness throughout, and preserving the greatest possible contrast between the lines and the ground. Although the stringency of the rules, specially applic-

able to the preparation of drawings in line for reproduction by photo-lithography or photo-typography, may be somewhat relaxed when drawing for reproduction by the photo-engraving or photo-collotype processes, which are more capable of giving lines of varying intensities, they are quite applicable to all drawings *in line* for photographic reproduction, and should be adhered to as far as practicable.

It has already been stated that in an ordinary lithograph or woodcut the lines or dots composing the design are all of the same intensity and blackness, and that gradation of shade is obtained by decreasing the thickness of the lines or placing them further apart. In order to produce the same effect by photography, the original drawing must be prepared in the same way, in strokes of an intense, even blackness on paper as clean and white as possible, in order to obtain from it a perfect photographic negative cliché, showing every stroke of the drawing clear and transparent upon an almost opaque ground. Unless the negative is of this character the best results cannot be obtained.

PAPER.

The first important point to be considered is the paper upon which the drawing should be prepared. This should, in all cases, be perfectly white, or slightly blue, rather than yellowish. The surface should be quite smooth. On rough paper it is impossible

to draw firm unbroken lines, especially if they are fine, and in photographing drawings on such paper, the asperities of the paper cast shadows which are liable to be reproduced in the photograph, and destroy the even opacity of the ground.

Good drawing paper should possess the following characteristics: thickness and good substance, good sizing, uniformity of texture, and good colour. The hand-made varieties are to be preferred to the machine-made.

For large maps, charts, plans, and other technical drawings, smooth-faced hot-pressed hand-made drawing paper is best, because it has a fine hard surface which will stand erasure. The softer and rougher kinds, quite suitable for water-colour painting, are not adapted for pen-and-ink drawing. Hot-pressed paper is, however, sometimes liable to be slightly greasy from oily matter taken up during its passage through the rollers of the glazing presses. A little oxgall may be added to the ink to correct this. Drawing paper of Hollingsworth's make has been specially recommended for this purpose, and is said to stand the damp Indian climate better than Whatman's.

Smooth machine-made lithographic printing paper has been found by experience in the Survey of India Office, Calcutta, to answer very well indeed for pen-and-ink drawing. It is of tough texture, and stands wear and tear well, also rubbing and damp; but the surface is glazed, and does not stand scratching well,

and this necessitates the use of Chinese white to conceal false lines instead of an eraser to remove them.

Paper with a very highly glazed surface is objectionable, both on account of its shine, which may interfere with the photographic operations, and also because it is wanting in a proper bite for the pens, and lines thicken.

A variety of different papers are now made by Continental manufacturers specially for photographic use, and some of these are also very suitable, though more adapted for drawings not required to be kept as original records. The same may be said of the continuation, cartridge, and other cheaper drawing papers, though these are often yellowish in tone and rough in surface.

The drawing paper may either be stretched on a drawing-board or frame, or loose. If stretched on a board, it is desirable, when practicable, to leave it so, in order to ensure its perfect flatness, till the drawing has been photographed.

In very damp weather, such as is experienced in India during the rainy season, drawing paper is very liable to become soft and porous in places, so that pen-and-ink work runs and colour work blots. Paper that has been kept through one rainy season should always be suspected, and should be tested before taking into use. Wet it, either by dipping into a bucket of water or with a sponge or broad brush, when, if the paper has become bad, spots will show themselves.

Such paper should be rejected at once. Sometimes, however, damaged paper may be made fit for use by resizing it with the following preparation, given in Smyth and Thuillier's *Manual of Surveying for India*, 3rd edition, p. 307. This preparation is specially useful in cases where the paper has become damaged during the progress of a drawing.

“Take a wash, composed of one drachm of isinglass, or good gelatine, steeped in two ounces of water for 12 hours. Then simmer it for 15 or 20 minutes over a fire. When nearly ready add of common alum (*phitkari*) in powder 20 grains, strain through linen for use; apply it when the paper is on the drawing board, and damp, and work it on with a flat brush; when dry, wash the paper over with water, which will indicate whether a second wash of the above is necessary. When the paper is thoroughly recovered, wash it well with plain water and a flat brush to take off any superfluous isinglass, absorbing the superfluous water with a clean linen rag. When thus prepared, the colours can be thrown in as safely as on good paper.”

With regard to the use of this preparation, Major Wilmer, of the Survey of India, writes:—“When I found that the paper upon which mapping had been begun was bad, in order to resize it I did not put the paper on a drawing-board, but placed the sheet—dry, face downward—on a clean table and pasted the edges down with strips of paper; when dry, damped it, put

on the size, and left it to dry. I found that the graticule had not become distorted, which I think might have been the case had it been damped before fixing it to the table."

Fine Bristol-board or good white cardboard is also an excellent material for pen-and-ink drawings. The surface is perfectly flat and even, and does not run the risk of being damaged by damping and stretching.

Paper or cardboard prepared with an enamelled surface of kaolin or China clay, and hence called "clay-faced," appears to be now extensively used for pen-and-ink sketches and drawings for photo-mechanical reproduction. By deftly scraping away the enamelled surface of the paper with an eraser or pen-knife, lines may be taken out without disturbing the smooth surface of the paper, and parts that are too dark may be lightened by scraping in white lines or dots with a point.

When necessary, drawings for reproduction may also be executed on tracing paper, but it should be fresh and white, or slightly bluish. Old tracing paper that has turned yellow and granular is useless, and should not, on any account, be employed if it can possibly be helped. Thin bank-post, or other thin white *wove* paper, should be used in preference.

Special tracing papers are now manufactured for use in connection with photography, and should be used in preference to the ordinary kinds. Tracing papers and tracings should be kept in the dark. Exposure

to light tends to discolour them and render them opaque.

Tracing or vellum cloth may also be used, but does not give such good results as good tracing paper. The highly glazed surface is sometimes slightly greasy, and lines are liable to thicken unless the ink is strong.

All drawings or tracings for reproduction by photography should, when practicable, be kept flat and not rolled. They should on no account be folded, and should be kept as clean as possible, and free from creases and wrinkles. Stains, folds, or creases will cause faint patches on the ground of the negative, which may result in the obscuring or blocking up of the lines of the drawing in those parts. Drawings that have been folded or creased should, if possible, be passed through a press before being copied.

INK.

The next important material is the *ink*. It may be black, or any strong pigment that will reproduce as quite black in a photograph, such as yellow, orange, burnt sienna, dark brown, red, or green; but, for many reasons, black is generally adopted.

The black pigments suitable are the different varieties of Indian or China ink—true and factitious—lampblack and ivory black.

Indian ink has always been universally recommended

and used for all kinds of technical drawings, on account of its stability when washed over and the difficulty of removing even strong lines by washing with a sponge or brush when once dry. This is undoubtedly an advantage in preparing shaded drawings, and in the case of valuable original maps and charts, where the permanency of the original drawing is of high importance. It is also an advantage in hot and damp climates, where drawings are liable to be smudged by damp hands or drops of perspiration falling on them. In other respects it is, perhaps, a disadvantage for pen-and-ink drawings for photographic reproduction, because a line once drawn cannot be washed out, but must be removed with penknife or eraser; the surface being roughened and made absorbent, so that lines re-drawn are liable to spread. The roughness caused by erasures is also often very much exaggerated in the reproduced photograph, and produces a very bad effect. In some cases this difficulty may be obviated by covering over the faulty parts with Chinese white and then redrawing—but it has a very untidy appearance on a finished drawing. The Chinese white can easily be removed with an eraser without damaging the surface of the paper.

When used thick enough to give intensely black fine lines, Indian ink is liable to show a glaze or shine which is often detrimental to the clearness of the lines when photographed. This is not the case with lamp-black or ivory black.

The best quality of genuine China ink should be used when practicable. It should be freshly and evenly rubbed down, slowly and on a smooth surface; if the ink is ground rapidly and on a rough surface, it will be gritty and give constant trouble with the pens. It should be used sufficiently thick to give full black lines. To test ink—a few lines may be drawn on the margin, noting the shade, how the ink flows from the pen, and whether the lines are sharp. After the lines have dried, pass a wet brush over them; if they wash readily, the ink is too soft and of inferior quality; if they resist the water and then wash tardily, the ink is good.

Mr. B. Day, of New York, writes in the *Scientific American*, Nov. 19th, 1887 :—

“Nothing is so good as freshly-ground Indian ink, which can be ground readily, perfectly and absolutely black, in an ordinary saucer, and is the very best working medium that can be used for pen or brush work. Any ordinary saucer will do, and for an inkstand buy a common brass thimble, to which fit a cork. Fill the thimble with water, as a measure of the quantity of ink required. Pour this into the saucer and rub up your Indian ink till you think it sufficiently black, then keep up the rubbing five or ten minutes longer. Now add one drop only of glycerine and rub a little more, and the ink is made. To mount the inkstand, cut a potato or turnip in half, scoop out a hollow for the thimble, using the flat cut surface as a base for

the inkstand, and when the pen fouls, jab it into the vegetable, which will clean it. To pour the ink from the saucer into the inkstand, make a long gutter of writing paper, by which it can be poured in without spilling a drop.

“For drawing on grained papers, lithographic crayons No. 1, Lemécier’s or Currier’s, are used, and can be mixed with pen work thereon. By warming the back of a drawing made with litho-crayons, they are fixed more firmly to the paper and made blacker. Drawings on enamel paper are made more readily with a brush than with a pen. Solid black can be painted in sparingly with a camel’s-hair brush. Pen lines run into these solids, impinging on the black, can be picked up with the point of a sharp scraper and carried into the solid, giving the effect of a wood engraving. This work can be cross lined with a brush, giving the effect of white stippling. All drawings for process work should be pure black and white, even the finest. The colour can be seen with a magnifying glass.”

Some experienced draughtsmen prefer not to use freshly-prepared ink, but to work it up daily with a cork, rubbing in fresh ink from time to time as required. It is obvious that great care must be taken to keep the ink free from dust, which would clog the pens.

No rule can be given for the choice of China ink; it can only be determined by experiment. By chance

one may succeed in obtaining a really excellent specimen; and once a good stick is found it should be carefully preserved. A black, bronzy, shiny appearance when broken is generally indicative of good ink, while, if it has a dull fracture, it will probably be inferior. When struck, a stick of fine ink gives a clear sharp sound; if the tone be dull, the ink is not homogeneous. The heaviest ink is the best; it improves in colour and brilliancy by age. Good ink is moderately scented with musk or Borneo camphor; but the scent and also the gilding and sharpness of the figures and lettering, tin-foil wrappers, or Chinese labels, are no criterion of quality.

According to Hamerton, good ink does not clog the pen, and gives perfectly black lines with washes of pure grey. Inferior ink rubs softly and thickly, does not give a pure black, and its washes are brownish. According to other authorities, the finest qualities are brownish in tint; when quite black, bluish or grey, they are inferior. H. R. Robertson, in his little work on *Pen and Ink Drawing*, says:—"The true ink is blackest when brought to a deep shade, but in the fainter shades it inclines to brown. The counterfeits have more substance towards the deep shades than the genuine. The true preserves a greater degree of transparency than the others."

When rubbed with water, good ink should be

perfectly free from grit, and there should be no sediment on adding a quantity of water. Without the slightest appearance of particles, its dry surface is covered with a pellicle of metallic appearance.

Good ink flows easily from the pen, even at a low temperature, and when once dry, a brush charged with water passed over it should not disturb it. This appears to be due to a chemical combination of the alum in the size of the paper with the gelatine or animal glue in the ink, because the same ink applied to marble or ivory will wash off.

It has been recommended to add to the Indian ink a little yellow, red, or brown pigment, such as chrome or Indian yellow, burnt sienna or sepia, for the purpose of strengthening the ink and making it more non-actinic by taking off any tendency to blue. The addition of a small quantity (about 1 per cent.) of bichromate of potash in powder to the ink, or rubbing the ink down with a weak solution of the bichromate (about 2 per cent.), has the same effect, with the further advantage of fixing the lines so that there is no risk of their being disturbed by subsequent washing with water or colour washes. This is of importance in using the inferior qualities of Indian ink generally met with. The animal glue in the ink combines with the salt of chromium under the influence of light and heat, or even spontaneously by keeping, and becomes quite insoluble. In using the bichromate care should be taken not to use more than is necessary to make

the lines insoluble, and to keep the ink thick, otherwise the yellow salt may spread beyond the lines, and cause them to thicken when reproduced. Gamboge is sometimes recommended to be added to the black ink, but in the writer's opinion it is undesirable, because it is liable to spread and to increase the glaze of the ink.

Liquid Indian ink can also be obtained, but, as usually prepared, does not give lines of sufficient blackness to reproduce well. M. Bourgeois, of 31 Rue du Caire, Paris, prepares a liquid Indian ink, containing a little yellow, which is said to be specially suitable for drawings and tracings to be reproduced by photography in the camera or by contact.

Lampblack gives very intense black lines, quite free from glaze, and works very smoothly with pen or brush, but is easily washed off the paper. The addition of bichromate of potash would, however, probably fix it, as in the case of Indian ink. The pigment may be used in the ordinary forms of water colour, or, as said by Suverkrop to be customary in America, fine dry lampblack may be ground up with a little gum and glycerine.

Ivory black is similar to lampblack, but more inclined to brown.

These pigment inks are particularly suitable when drawing with the brush, because they give a good body of colour.

For drawing with a pen, Mr. H. R. Robertson

specially recommends "Stephen's Ebony Stain" as having more body than any simple ink, while at the same time it is not thickened to such a degree as to prevent the pen or brush from making the very finest lines. The stain may also be used with the brush, though it yields a somewhat shining surface.

The writer has not had an opportunity of trying this stain, as it is not obtainable in India. It seems probable that it is a form of logwood ink, one of the best of which may be made by taking of extract of logwood 15 parts, neutral chromate of potash 1 part, crystallised carbonate of soda 4 parts, water 1000 parts; the extract of logwood is dissolved in 900 parts of water, decanted off from any deposit, and boiled; the carbonate of soda is next added, and then, drop by drop, the chromate of potash dissolved in 100 parts of the water. This forms an excellent ink of good colour, flowing very readily and smoothly from the pen. The logwood inks, however, are liable to thicken very quickly—though that prepared as above is said not to do so.

Ordinary writing inks are not very suitable for maps or technical drawings, on account of their corroding the ruling pens, though they will answer well for sketches, provided the ink gives a fine line of full blackness, not inclining to blue.

When it is necessary to use coloured inks, any suitable water-colour pigment may be used, or solutions of the aniline dyes. For lines or details required

to reproduce black, the following pigments may be used:—*Red*: Carmine (strong), or vermilion. *Brown*: burnt sienna, burnt umber, sepia, and other dark browns. *Green*: Dark green, or other greens tending to yellow rather than to blue. *Yellow*: Chrome and other strong yellows. *Blue*: Indigo (strong). For lines or details not required to reproduce, pale cobalt blue may be used, or solutions of the aniline dyes, blue, violet or red (roseine); the latter may be used comparatively strong. Great care must be taken to keep these light inks free from any admixture with black by the use of dirty pens or brushes.

PENS.

The pens to be used vary according to the nature of the drawing. The lithographic crow-quill pens, and the etching and tracing pens, manufactured by Messrs. Perry, as well as the lithographic crow-quills and a drawing pen (No. 303) made by Messrs. Gillott and Co., seem to be generally preferred for fine pen-and-ink work, but other varieties of ordinary writing pens will also be found useful for stronger work or special effects. For coarser and bolder drawings, goose-quill or reed pens may be used with advantage.

In drawing with the steel crow-quill pens, Mr. Robertson recommends their being mounted on a holder of the ordinary thickness.

Special penholders are made for this purpose, but an ordinary holder may be adapted by cutting it as shown in the diagram. These pens can also often be fitted on the pencil point of an ordinary sliding pocket pencil case:—



Very exact careful work in pure line may be done with a fine brush instead of a pen. The small sable brushes used for lithographic drawing are suitable. These are good red sable crow-quill pencils (No. 1) with part of the hair cut away all round, leaving only the central part forming a good point.



The use of the brush requires some little practice, and the strokes must be made slowly and deliberately. There is not the same freedom as with a pen, but once facility is attained, the brush can be used with considerable rapidity, and the pen will not be readily taken to again. The brush works very smoothly, gives a firmer line, and cannot tear up the surface of the paper or catch in its fibres as does the pen. It is not suitable for fluid inks, but should be used with pigments containing a certain amount of body

in order to obtain solid fine lines. Indian ink, ivory black, and lampblack are all suitable, the latter by preference.

OUTLINING.

The outlining or tracing in pencil requires care in keeping the drawing clean. A hard pencil of *the best quality* (H H H, H, or F) should be used. It should make a light but distinct mark without indenting the paper. The pencilling should be done as lightly as possible and kept within the smallest necessary limits. The fewer pencil lines on the drawing the better.

If the pencilling is quite light it can be left without doing harm in the reproduction, but if it is at all dark, it should be lightly rubbed out with stale bread before beginning the inking in, leaving only enough visible to serve as a guide. By removing pencil lines after the inking in, the blackness and firmness of the ink lines is injured, and they may reproduce rotten and broken. On the other hand, if darkish pencil lines be left under the inking, they are liable to reproduce and cause a blocking up in close parts of the work. Carbonic papers or red chalk copying paper should never be employed for making the tracings on drawings for photographic reproduction. The use of similar papers prepared with a light blue pigment is admissible. Outlining and tracing may also be

done in pale blue ink, and this is better than pencil when it can be done.

When possible, it is better to trace in ink direct with the tracing glass. By placing the tracing glass horizontally under a framework, covered with black calico and reflecting light upwards from below, the tracing will be much facilitated.

INKING.

Before commencing the inking in, it is desirable to protect the drawing from dirt and dust by covering it up in paper, only allowing the portion that is being worked upon to be exposed. If the drawing paper is not stretched on a drawing board, it is a good plan to put it in a cardboard frame, made like a blotting pad, with a sheet of clean paper over it. The inking in of the drawing must be done entirely in pure black lines or dots of uniform intensity, without half-tones of paler tint or shading by washes. The lines should be firmly and clearly drawn, smooth, even, and unbroken, not too fine or too close together. Even the finest lines must be quite black. Light effects must be produced by making the lines thinner and increasing their distance apart, and not by the use of pale ink. Thick lines in the printing, borders, &c., should be well filled in.

Dark shading for shadows, &c., whether in single lines or crossed, should be open and in firm clear lines

of suitable thickness, not too close together or crossed and re-crossed with fine lines. Intensity of shade should be shown by an increase in the thickness of the lines rather than by their being placed close together. It must be borne in mind that in photo-zincography, and other transfer processes, there is a tendency for the lines to thicken, so that if they are too close they are liable to block up in the printing, and the work will appear heavy and unsightly. All shading should therefore have a somewhat lighter and more open effect in the original than it is intended to have in the copy.

Hill-shading on maps should, as a rule, be shown in single strokes, whether vertical or horizontal, crossing being reserved only for precipitous scarps or other special features.

In drawing maps or plans for reproduction to scale by photo-zincography or similar processes, it is better to leave river-courses, coast-lines, lakes, ponds, or tanks blank instead of shading them in with fine close lines. They may be indicated on the original drawing by a pale wash of blue without detriment to their reproduction. If necessary the shading can be done by hand upon the plate or stone, or the printed copies can be coloured. In preparing drawings for reduction this is not of so much consequence if the lines are kept well open and of due thickness. In reproducing very fine lines to scale, there is always a tendency for them to thicken unduly. In reducing, the relative

proportion between different thicknesses of lines is better preserved.

Similarly, in mechanical or architectural drawings to be reproduced to scale, ruled tints or shades are better left blank on the original, or shown by light tints of cobalt blue, aniline violet, or aniline red (roseine). Engraved tints in lines or dots can be transferred on the stone or plate afterwards, and will have a much neater effect than tint lines reproduced directly from an original drawing, unless they have been very carefully and regularly drawn with a Maginnis' Dead-beat Sectioner, or some similar arrangement for ensuring the parallelism and uniformly regular thickness and spacing of the lines.

Lines of axis, section, projection, water level, &c., usually shown in red or blue, should be drawn in black ink, in dotted lines of various kinds, so as to be easily distinguishable.

Washes or shading of any colour, except pale blue, violet, aniline red, or other colours which will not reproduce, are absolutely inadmissible in drawing for reproduction by ordinary photo-lithography, photo-zincography, or the various methods of photo-block printing, known as "process," specially suitable for line work. If necessary, outlines may be drawn in the pigments already noticed, *viz.*, dark red, brown, yellow, orange, or green, which will reproduce black.

Details required to be shown on the original drawing, but not on the reproduced copies, may be drawn

in with pale cobalt blue, or with any of the aniline blues, violets, or magenta. Spots, stains, and details not required to be reproduced, or faulty lines, can be painted out with Chinese white.

Whenever practicable, the original drawing should be made on a larger scale than the reproduced copy. Defects in drawing are lessened by reduction, and, as noticed above, the result generally is finer and sharper, and the relative thickness of the lines is better preserved than in reproducing to scale.

In copying engraved maps and other very fine engravings or drawings, a slight enlargement is an improvement.

In preparing drawings for reduction, considerable skill and experience are required in drawing the lines, lettering, and detail of sufficient thickness and size relatively to the scale of reduction, so that they may be clear and distinct and in proper proportion together when reduced. The necessity for this rule is not always apparent at first sight, and it constantly happens that drawings, &c., are sent in to be reduced far more than they will stand, the consequence being that details and names become so small and faint as to have either entirely disappeared in the progress of the photographic manipulations, and are broken and indistinct, or so minute as to be quite illegible.

Thus, if a drawing is to be reduced to one-fourth its linear scale, every line must be drawn four times as thick, and the writing and details four times as large

as required in the reduced copy. The white spaces between lines of shading or cross-hatching must also be proportionately large in order to prevent the lines blocking up and running together in transferring and printing, whether on stone, zinc-plate, or block. The specimens of ruled lines and lettering on different scales, given in Plates I. and II., will serve to illustrate this.

If the scale of reduction is too great, the whole general effect of a drawing is liable to be altered; and practically it is sufficient to draw the original from about one-and-a-half (3 to 2 linear) to twice as large (4 to 2) as the copy, to secure all the advantages of reduction, and without so great an exaggeration of lines and details as to render the drawing unsuitable also for reproduction, if desired. The draughtsman has not so much difficulty in judging what the effect of his drawing will be when reduced as when drawing on larger scales and the size of the drawings is not unduly increased. Even when drawing for reduction from 2 to 1, considerable practice is required to enable the draughtsman to judge the effect of reduction on his drawing, and to get into the habit of drawing in a much more open style than would be suitable for finished drawings on the same scale. He also has to avoid too much finish, taking care not to crowd in lines in the shaded parts, and not to use more lines than are just necessary to produce the desired effect when reduced. (See Plate III.)

At the Ordnance Survey Office, Southampton, it has been found convenient for the reproduction of the six-inch photo-zincographed maps to reduce them direct from the original sheets on the scale of 25 inches to the mile, or rather more than 4 to 1. A uniform system of suitably drawing and lettering the original maps on the twenty-five-inch scale has been adopted, and no difficulty is found in working it.

In preparing maps specially for reduction, care should be taken not to overcrowd the drawing with names or minor details beyond what are suitable and necessary for a map on the proposed reduced scale. The minor details of bends of streams, boundaries, cultivation, footpaths, small streams, &c., should be omitted or generalised, otherwise the reduced map becomes confused with useless items.

It is difficult to give rules for the proper thickness of lines and width of spacing in drawings prepared for reduction by photo-zincography, but it may be taken as a general rule that the smallest space that will practically print well on zinc or stone without blocking up is the $\frac{1}{200}$ of an inch, while the finest line that will reproduce well is about the $\frac{1}{600}$ of an inch, and, therefore, on a drawing intended for reduction to one-fourth, the smallest open space admissible between lines of shading, &c., would be the $\frac{1}{80}$ of an inch, and the finest line about the $\frac{1}{125}$ of an inch, the thick lines being drawn in proportion. On a drawing to be reduced one-half the smallest open space

should not be less than $\frac{1}{100}$ of an inch, and the finest line $\frac{1}{250}$. Some of the block processes depending on the use of asphaltum, in which the image is printed directly from the negative by contact, admit of still finer and closer work being printed without running together, but, for the transfer block processes, and for ordinary photo-lithography or photo-zincography by transfer, the writer believes that the above will be found a practically safe rule.

The best way of ascertaining the proper style for making drawings for reduction is to take a drawing or print showing the proper effect on the reduced scale, and then enlarge it in the camera by one-half, or up to double the original scale, or even more, as may be required. The enlargement will show at once the proper thickness and size of lines and lettering, as well as the spacing of shaded parts.

It will save confusion and mistakes if on plans or drawings intended for reduction the scale is shown in terms of a single unit of measurement, *i.e.*, as "Scale of inches, feet, yards, miles," &c., and not as relative to any second unit, as "Scale of 6 inches = 1 mile," or "Scale 10 feet to 1 inch." On drawings intended only for reproduction to scale it is immaterial how the scale is shown.

All through the progress of the drawing the surface of the paper should be kept quite clean and free from dust, or spots and stains. As before noted, it is well to keep the drawing flat, covering it up with clean

paper, and only uncovering and inking in portions at a time. It is sometimes recommended to put drawings away in a woollen bag between the intervals of work.

In cleaning up the drawing, after inking, the utmost possible care should be taken to avoid injuring the firmness and solidity of the lines. India-rubber or ink erasers should not, on any account, be used for this purpose. The best thing to use is a piece of bread not quite fresh but not too dry. Fresh bread is almost as bad as India-rubber, but the stale bread cleans the surface well, and does not injure it. If the bread be too dry and hard it is useless.

In making erasures, the surface of the paper should not be disturbed more than is absolutely necessary. Worthen recommends that when ink lines to any considerable extent have to be erased, a small piece of damp sponge may be rubbed over them till they disappear, care being taken to remove all discolouration of the paper by a second wash with clean water.

For ordinary erasures of small ink lines, a sharp rounded pen-blade or steel eraser applied rapidly and lightly does well, and the surface may be smoothed down with the thumb-nail, an ivory paper-knife, or other perfectly clean, hard *polished*, and *rounded* surface. A cowrie shell answers very well. In making erasures with the knife, a hard smooth surface, such as the blade of a paper-knife or an ivory protractor or scale, should always be placed under the

paper where the erasure is to be made. In ordinary working drawings a line may readily be taken out by damping it with a hair-pencil and quickly applying the India-rubber, the surface of the paper being smoothed with the paper-knife. In some cases erasures may conveniently be made with a piece of fine glass-paper rubbed over the surface. Small defects, such as ink lines drawn beyond their proper limit, which it would injure other parts of the drawing to remove with the knife, may be covered over with Chinese white.

In preparing finished drawings, special care should be taken to avoid all necessity for erasures as far as possible. They not only reflect on the carefulness of the draughtsman and detract from the neat appearance of the drawing, but may also be highly injurious to its successful reproduction by causing lines redrawn on the erased surface to be coarse and ragged, and attracting dust and dirt, which will lower the intensity of the negative in these parts, and may cause the lines to thicken and block up.

It may here be repeated that photography has a peculiar tendency to exaggerate slight imperfections, and that spots, stains, roughness of surface, almost imperceptible on the original, may be reproduced most clearly and distinctly on the copy.

All hand-printing and writing should be done as neatly as possible. The hair strokes of letters should not be too fine. Writing, which will look neat enough

on the original manuscript, will present a very rough unfinished appearance unless the letters are really well formed and regular in spacing and parallelism.

It must be borne in mind throughout, that photography will only produce a *fac-simile*, and that, as a rule, the original will not in any way be improved upon, unless, perhaps, by reduction. Rough coarse drawing will not appear like fine engraving, or bad and ill-formed lettering like letterpress or copperplate. In making finished drawings for publication, therefore, due care must be taken to give them the requisite degree of neatness and finish before they are copied, so that the result may be fit for immediate issue, and not require alteration and touching up, which entail delay and expense, and not unfrequently seriously injure the work before it is printed.

CHAPTER IV.

PREPARATION OF TRACINGS AND TRACING PRINTS IN LINE.

For photographic reproduction in the camera, good original drawings on paper are preferable to tracings either on tracing paper or cloth. However, it is often a very great convenience to be able to trace a drawing instead of redoing it afresh, and, if proper care be taken, equally good results may be obtained from tracings as from drawings on opaque paper.

For obtaining photographic prints, on the same scale as the original, without the aid of the camera, by means of the cyanotype and similar methods of photographic printing, and also in some processes of photo-zincography, the original drawing is placed in close contact with the sensitive coating of the prepared paper or zinc plate, and the light allowed to act through it. The best results are only obtainable by the use of drawings made on a very translucent material of even texture, such as fine white tracing paper or good tracing cloth, with a strong and opaque ink.

TRACING PAPER.

For tracings on paper the principal point is the selection of the paper. It should be thin, and as translucent as possible, white or bluish white in colour, of uniform grain and texture, and quite free from spots or stains.

The white tracing paper, specially prepared by Messrs. Schleicher and Schull, of Düren, for contact printing with the cyanotype processes, has been found by the writer to keep its whiteness and transparency very well in India. It is thin, very translucent, and of even texture and grain.

The lighter yellowish tinted tracing papers, which will answer perfectly well for purely tracing purposes, or for lithographic tracing-transfer drawings, are not so suitable as the whiter kinds for photographic work. When suitable tracing paper is not available, it may be worth while to prepare it specially by taking a fine white thin paper, such as thin photographic paper or bank-post paper, and rendering it translucent with white vaseline or paraffin wax, the greasiness of the surface being overcome by washing with oxgall or rubbing over with powdered French chalk. Most of the recipes given in the books, in which mixtures of turpentine and Canada balsam, white resin or mastic varnish, are recommended for rendering the paper translucent, yield tracing paper of a yellowish tinge,

which becomes deeper by age. Old tracing paper that has turned yellow is quite unsuitable for copying, either in the camera or by contact. It is impossible to get a clean ground with such paper, even with long exposure.

TRACING CLOTH.

Owing to its better colour, greater strength, and its not being liable to be cut through by ruling pens, together with other advantages, tracing or vellum-cloth is generally preferred to paper for tracing purposes, but it is not altogether so suitable for drawings for photographic reproduction. Unless special care be taken to keep the ink thick and black, there is a great tendency for the lines to run pale, and also to thicken. Although this may not be very noticeable when looking at the drawing, the photographic negative will be imperfect, and the result disappointing. Major Gore, R.E., finds that a slight rubbing with ordinary black India-rubber greatly improves the surface of tracing cloth for taking ink lines.

INKING IN.

Tracings prepared for contact printing should be drawn entirely in black lines, firm or dotted, with a good thickness of ink, so that they may be quite opaque. Some burnt sienna, raw sienna, or chrome yellow, may be added to the ink to give it additional

opacity. Great care must be taken to keep the back of the tracing clean and free from marks which might print through or show on the negative.

Tracings should not be coloured. If the use of colour should be obligatory, lines may be drawn in vermilion, burnt sienna, burnt umber, chrome yellow, and dark green, thickly rubbed down so that they may be opaque.

If drawings or prints are not on too thick paper, they may be made transparent for copying by contact, by applying a mixture of one part of castor oil and five parts of alcohol or spirits of wine. If necessary, the oil can easily be removed afterwards by soaking the drawing in spirits of wine.

At the Forest Survey Office, at Dehra Dun, in India, the writer saw in operation a method of preparing tracings on thin paper for reproduction by photography which gives very excellent results.

For tracing, a horizontal table is used, having a large sheet of plate-glass let into the upper surface. Below the glass plate, facing outwards, a reflector, made of sheet tin, is placed at an angle of 45° , or so as to conveniently reflect light on to the paper above. The table is placed in front of an open window; the front and side lights are screened off with curtains, so that the reflected light shines clearly through the original drawing, which in this case was on thin paper backed with calico.

The tracing is done directly in ink, which avoids

all soiling of the drawing with pencil lines, and consequently no cleaning up or rubbing out is required, and the lines retain all their sharpness and blackness. It is, however, difficult to judge of the effect of the drawing when viewed by transmitted light, especially with another similar drawing below it.

The lettering is printed in type, upon slips of the same paper as the drawing itself, and where the names are curved are cut out letter by letter, and pasted on carefully with gelatine, kept warm in a small glue-pot placed beside the draughtsman.

The paper, being thin, will not stand erasures; faulty parts are therefore covered over with slips of paper pasted on in the same way as the type slips. The edges of these slips are bevelled off, so as not to throw a shadow in photographing.

NEGATIVE TRACINGS.

When used for contact printing from tracings, the ordinary cyanotype process is open to the objection that the lines appear in white on a dark blue ground. This may be avoided by using *negative* tracings, prepared in the following manner:—

The tracing is drawn, in the first instance, on fine white, thin, and very translucent tracing paper with *lithographic* writing ink, such as is used by lithographers for drawing on stone or lithographic transfer paper.

That made by Vanhymbeck is best, and is sold in sticks.

The ink must be rubbed down carefully with *distilled* water or rain water; ordinary hard water will not do. Small pieces of the ink may be cut off the stick, moistened by sprinkling with a few drops of the water, and rubbed down with the finger on a china slab or a small plate till the ink is all dissolved, water being added as required to obtain a proper consistency of ink. Or the plate may be warmed and rubbed over thinly with the stick of ink. A few drops of water are added, and the ink worked down with the finger as before. In this case the colour or opacity of the ink is of no consequence, but it should neither be too thin, so as to flow too freely from the pen, nor too thick, so as not to work pleasantly. For working with the pen the ink may be thinner than when working with the brush, which should be cut as described in the last chapter. Being of a soft and soapy nature, the use of lithographic ink is difficult at first and requires a little practice. Great care has to be taken not to smear the lines, which is especially liable to occur if the ink be used thick.

When the tracing is finished, it is pinned down, face upwards, on a sheet of blotting paper, and brushed over lightly with a soft brush once or twice with a strong solution in water of aniline brown (Bismarck brown is very suitable) and allowed to dry thoroughly.

Properly performed, this operation should not injure the drawing.

The lithographic ink is then removed by rubbing the drawing over gently with a tuft of cotton-wool soaked in turpentine, till no trace of it remains on the paper. The turpentine is allowed to evaporate, and when the tracing is removed from the blotting paper, it will be found transformed into a very perfect negative with clear lines and a dark orange-brown ground, very non-actinic. Great care must be taken that none of the dye gets on the back of the tracing over the lines.

Major St. G. Gore, R.E., of the Survey of India, has recently found that negative tracings of this kind may also be prepared by drawing with the ordinary country writing ink, which is a compound of lampblack and gum or other colloid matter, and then brushing over the whole with an even coating of a mixture of lampblack, linseed oil, and gold size. When the ink is dry the original drawing is washed off with water.

The prints produced by Major Gore from these negative tracings are exceedingly good, and the process seems likely to be a very useful one, especially in the field, for copying reconnaissances, field sketches, &c.

TRACING PRINTS.

. It is sometimes desired to reproduce maps, plans, &c., with extensive alterations, either as corrections

or such as might be necessary in generalising a map or plan on a large scale and full of detail, preparatory to reducing it to a smaller scale with much less detail.

In redrawing a map or plan in this manner, it is a great convenience to the draughtsman to work upon a *fac-simile* copy of the original map, provided that the lines are in some pale colour which will not reproduce by photography, and will allow the new drawing to show clearly over it.

When the original map or plan has already been printed, and the stone or zinc plate is still available, it is easy to print impressions of it in light blue or grey ink, upon which the new drawing can be made. This method has been in use for many years in the Survey of India Department, and has been found most valuable; but the prints have the defect of being always slightly greasy, and difficult to draw upon, and the blue ink has a tendency to turn green, so that details not required are liable to reproduce, or at any rate interfere with the clearness and sharpness of the lines, especially in parts where the work lies close.

Another method has recently been introduced which is quite free from these defects, and has the further important advantage of being applicable to any subject of which a spare black impression is available.

It consists in evenly pasting a sheet of thin bank-post paper over a black impression of the map or plan to be redrawn. The black lines, and other details, show through quite clearly enough to enable the

draughtsman to go over them with Indian ink, introducing any changes and alterations that may be necessary; though they will be too faint to interfere in any way with the clearness of the drawing, or to reproduce when photographed.

The surface given by the bank-post paper is smooth and pleasant to work upon, and, quite free from all greasiness.

The best way of applying the paper is to coat sheets of thin bank-post paper with a thin clear solution of gelatine and allow to dry. When required for use, a sheet of this gelatinised paper is laid between sheets of damped paper—an ordinary lithographer's damping book—together with the printed copy of the map or plan to be redrawn. When sufficiently damp, the damped print is laid, face upwards, in a lithographic press on a sheet of polished zinc or a lithographic stone; the gelatinised paper is laid over it, and the two are passed through the press. The paper is thus made to adhere very evenly to the printed sheet, and, when dry, is ready for the draughtsman.

When printed impressions are not available, the original subject may be redrawn in Indian ink, on white tracing paper; or, if other considerations render it desirable, it may be photographed and redrawn in black upon pale blue cyanotype prints.

A method, practised by the Map Engraving Company in New York, is to draw in black over a silver-

print on arrowroot paper. When the drawing is complete, the photographic image is bleached out by means of a solution of bichloride of mercury in spirits of wine.

These methods give great accuracy, and save the trouble of tracing and redrawing independently in cases where the use of thin tracing paper would be unsuitable. They also greatly facilitate additions or omissions, and enable the style of drawing on a bad original to be improved ; or where an original drawing is not suitable for reduction, the new drawing can easily be made so.

CHAPTER V.

TYPE-PRINTING FOR MAPS AND TECHNICAL DRAWINGS.

ALTHOUGH nothing can surpass in neatness and congruity really good hand-printing on manuscript drawings, maps, or plans, the increasing difficulty of obtaining first-class hand-printers and of training them to uniformity of style has led to the very general adoption of type-printing as a means of securing neatness of appearance, regularity and uniformity in the lettering of maps, plans, and other technical drawings required for public purposes or in large private workshops, as well as by the publishers of cartographical or technical works and periodicals.

If the type selected be suitable in style and size, and well applied to the drawings, the effect is neater than ordinary hand-printing, is done in less time, and requires no special skill.

For photographic reproduction it is most important that the impressions from the type should be as perfect as possible, sharp, clear, and uniformly black. The paper must not be indented so as to cause hollows, which produce shadows when being reproduced in the

camera and thicken out the letters on the negative. The ink used should be free from oily matters, which are liable to spread round the letters; and although the yellowing caused by this may not be visible to the eye, it will affect the photographic plate and cause the names to thicken out and reproduce heavier than they should do. It often happens that typed lettering, which appears passably sharp and clear on the original drawing, reproduces badly. On examination, however, it will generally be found due to some fault in the original.

Typing may be done either direct on to the drawing itself, or on slips of paper which are pasted on in position. When it can be well done the former system is to be preferred, but it has the disadvantage that a faulty name once placed cannot be removed or corrected, though weak impressions may be touched up by hand.

In typing direct on a drawing the fineness and sharpness of the results depend a great deal on the nature of the pad or support upon which the drawing is placed while being typed, and the amount of pressure given to the type. These again vary according to the size of the type used. As a rule, a small-sized type requires a thinner pad and less pressure than type of a larger size. It requires some experience to learn the kind of pad and amount of pressure required by different founts of type.

It is a common custom to use a soft pad of several

sheets of blotting paper, or a sheet of India-rubber, under the drawing when typing. The result is, that the name is pressed deeply into the paper, and gives a heavy impression, which becomes still heavier when photographed, as explained above. It is easier to work with a soft pad, but with a little extra care and trouble in using a hard pad, such as a sheet of cardboard, much clearer and sharper impressions will be obtained. Although the pressure required will be greater, the indentation will be little or none.

When drawings are thus indented by the type, it is a good plan to pass them through a lithographic or copperplate press before photographing them.

The system of typing on separate slips of paper, and pasting the names or single letters in position on the drawing, has the advantage of saving all indenting of the drawing by the type, and enables mistakes or bad typing to be easily rectified. A name found to be faulty can easily be removed and replaced by another impression. There are, however, objections to this system, which render its adoption undesirable for highly-finished closely-drawn work. The thickness of the paper causes a shadow to be thrown on the under side when being reproduced in the camera, causing a clear line on the negative, which has to be stopped out. It is difficult to do this neatly where the work is close. The paper on which the names are printed should, therefore, be as thin as possible, without being sufficiently transparent to allow any other details to

show-through and obscure the printing. The paper should be of the same colour as the rest of the drawing.

The separate slips must be securely attached to the drawing, otherwise they fall off or get creased and torn. Clean gum, gelatine, or white paste should be used. The addition of a little alum will render the mucilage less liable to be attacked by damp. Care should be taken not to allow the adhesive material to spread over the paper beyond the slip. It will attract dirt and dust, and cause markings on the negatives which it may be difficult to stop out without obscuring details. The best plan will be to apply it to the back of the paper before cutting the slips. A little moisture will make them adhere firmly without danger of the gum or paste exuding.

In places where the drawing is close, after the name-slips have been pasted on, the details of the drawing should be completed round the names, or separate letters of an extended name. Square-cut blanks have a very bad effect.

Typing upon tracings intended for reproduction by the cyanotype or other contact-printing methods must, of course, be done upon the tracing itself, and not upon slips. If the ink does not give sufficient opacity to show the names clearly on the prints, yellow or red bronze powder may be brushed over them. This adheres only to the tacky ink lines, and makes them perfectly opaque.

Considerable care and skill are required in the proper placing of the typed names on drawings, because there is not the same adaptability in the use of type as there is in hand-printing. Words cannot be so easily divided or curves followed. A great deal may be done to improve the effect of typing by judicious spacing. In typing numbers the introduction of a small space between each component figure is a great improvement.

It is difficult to give any general rule for the arrangement of lettering, because each description of drawing, whether a map, plan, architectural or mechanical drawing, has different requirements. The rules ordinarily applicable to the lettering of such drawings by hand also apply to type lettering as far as they can be carried out.

As a general rule, the principal lettering and all titles, references, foot-notes, &c., should be parallel to the base of the drawing. In plans or other drawings, where lettering may run across the drawing, it should, as far as possible, be placed parallel to the lines or details it refers to.

Nothing has a worse effect than names typed askew or placed obliquely in all directions without any apparent cause. If names have to be typed obliquely, it will improve their appearance to curve them. The placing of single letters in curves also requires judgment, but with care it can be done without difficulty in a manner we shall describe hereafter.

The type used should, when practicable, be of extra hard metal, so that it may better stand the wear and tear, and not be so liable to damage.

Type should be carefully kept in separate founts, each arranged in the ordinary type cases, and after use should be sorted and put back in its place in the trays to which it belongs.

The type-holders used in the Survey of India Department are of two kinds, the ordinary vertical spring pressure holder, used for stamping single names, and the Gastrell machine, which is larger and works with a lever, and is used for foot-notes, headings, &c.

The small holder is composed of two parts, the holder for the type and a socket with a triangular basis, which rests on the drawing. The holder can be placed at any part of the drawing at will.

The type should always be placed as nearly as possible under the centre of pressure, *i.e.*, the handle of the holder. Great care should be taken to make the face of the type level, so that the pressure in printing may be uniform, and the whole word should be in one straight line. When using small type a piece of wood, of suitable shape, should be introduced into the holder, to fill up part of the type frame to save the flat spring from undue tension.

In order to secure the printed names to the base of the drawing, the following by Lieutenant-Colonel Wilkins, of the Royal Artillery, may be followed. The socket of the

be mounted on a piece of wood or millboard (its own foot-screws will suffice to attach it to the millboard); lines are then ruled, in different colours, across the millboard parallel to one another and to the line of type in the holder, at about an eighth of an inch apart. They are numbered at both ends.

On a map where there are graticule lines parallel to the base of the map, it is sufficient to bring the two ends of any line on the millboard to coincide with one of the graticule lines, and the name will be printed parallel to it. On drawings where there are no such guide lines, lines may be ruled at intervals in pale blue ink or in pencil.

If it is desired to print letters on a curve in an extended name, a curve is laid down on the drawing, and its centre is marked; radii are drawn in the direction of each letter of the name, and a hair, which is mounted on a slit on the millboard perpendicular to the line of type, is aligned with each radius, and the letter is stamped at the point required.

A proof should always be taken of every word or name on a separate piece of paper before it is typed on the map or drawing, in order to ascertain whether the setting is correct, the type evenly placed in the line, and every letter free from defects.

Colonel Wilmer, of the Survey of India, has expressed the name being perfect and printed by the following method.

of the board or plate which carries

the hand-stamping machine is covered with a slip of sandpaper, pasted on rough side downwards under this is placed a piece of tracing paper, upon which the impression of the name is stamped, and corrected if imperfect. The type-holder, with the tracing paper held in position by the sandpaper, can then be removed to any part of the paper; and the impression on the tracing paper fixed in the proper position. The tracing paper is then torn away, and the type impression is made exactly in the position occupied by the impression on the tracing paper.

The Commandant de la Noë, of the French *Corps du Génie*, has invented a type-stamping machine, which seemed to the writer to work very effectively, and to be an improvement on those ordinarily in use. It gives a very clean sharp impression without indenting the paper. The distinctive principle of the machine is, that the type-holder has a rocking motion over a hard cylindrical support made of brass, covered with a few folds of blotting paper, on which the drawing paper is placed. In typing, the impression commences at one end of the word and ends at the other, so that each letter is in contact with the paper only when making its impression. This instrument was tried in the Survey of India Offices, and not found very convenient for large sheets of paper. For such it would be better to use a cylindrical table large enough to take a full sheet of drawing paper.

The printing ink used should be the best black

letterpress ink, made up as stiff as it can be used. It should be sticky between the roller and slab, and give a crackle when rolled on the slab. Thin ink is useless: it does not dry, and it smears readily. Should the stock of ink become hard, a little balsam of copaiba may be added to it, but on no account should it be thinned with lithographic oil, varnish, or other oily material, which would cause it to spread as before explained.

The ink should be renewed daily, and the slab cleaned with a little turpentine every day after use. According to some authorities it is better to mix up the printing ink the day before use—preserving it carefully from dust. It dries more quickly.

The following recipe for a superfine printing ink, which is used for pulling proofs of fine engravings, is recommended as the best by Colonel E. H. Steel, of the Survey of India, from whose memorandum on the subject much of the above information has been taken. It makes 1 lb. of ink:—

Balsam of copaiba	. . . . .	9 ounces.
Lampblack	. . . . .	3 "
Indigo or Prussian blue, or equal parts		
of each	. . . . .	1½ "
Indian red	. . . . .	¾ "
Dry yellow turpentine soap	. . . . .	3 "

ground with a muller on a stone slab to an impalpable smoothness.

A small quantity of the ink should be rolled on

the slab; practice only will determine the exact amount required with each sort of type. Large type necessarily takes more than small, and does not require such a stiff ink. A light even roll backwards and forwards with the roller on the face of the type is all that is required to ink up a name.

For inking the type small hand-rollers of India-rubber are generally used. They may easily be made by putting a piece of India-rubber tubing over a wooden cylindrical core about $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter and about 3 inches long, mounted in a forked handle. The rollers should be kept clean after use by washing with soap and water, or with a sponge dipped in turpentine or paraffin, then wiped quickly to remove the ink and turpentine, sponged with water and wiped with a soft cloth until perfectly dry and all glossiness is removed from the face. Should the rollers have become tacky by constant washing with turpentine, they should be rubbed over with powdered whiting, sponged with water, and wiped dry.

It is essential to keep type clean, so as to obtain from it impressions that shall be perfectly fine, clear, and black. Black and clear they will not be unless the old dry ink is removed from the face of the type, and fine they cannot be if the face and hair lines of the type are destroyed by careless treatment in cleaning and storing.

The best way of keeping type in good order is that

recommended by Colonel Wilkins, of the Survey of India.

After an impression has been taken, and before the type is removed from the holder, it is cleaned with a soft camel's-hair brush dipped in turpentine, lightly passed over it, and then dabbed gently with a ball of cotton wool. Type is thus always kept clean in the tray.

The dabbing may be dispensed with, as the type will probably not be wanted until the turpentine has dried.

The typer should have by his side, *away from the drawing*, a little pot of turpentine; it is no trouble using it.

If the ink is allowed to dry on the type, the *eyes* of the letters will get blocked up with hard ink, which will give some trouble to remove, and the type may be damaged or worn in doing so.

When ink has hardened on the type, it is best removed by boiling in a pot with a strong solution of potash or soda (*bazaar saji-matti*) and water, about 1lb. to a gallon of water. It is set up afterwards on a type-board, brushed lightly with a soft brush wetted in the same solution, and dried off with cotton wool.

If it is necessary to clean the fresh ink off the type when in the holder, a piece of wash-leather should be used, and not a rag or cotton cloth, the fibres from which would get into the ink and render the impression woolly.

The style and size of type to be used should correspond as nearly as possible with what would be used in hand-printing. As already noted, in drawing for reduction the type used must be large in proportion to the reduction required. A great defect of type for purposes of reduction is that the hair strokes are generally far too thin in proportion to the body strokes. For this reason the stouter sanserif types have come into general use, though they are not so well adapted for mapping purposes as the roundhand type, which is more like the style of ordinary hand-printing. For the use of the Ordnance Survey Office at Southampton, special founts of type have been cut and cast in imitation of the italic engraved letters called *stump*, which are usually employed by map engravers.

CHAPTER VI.

HALF-TONE DRAWINGS IN WASH,—MONOCHROME, OR COLOUR.

So long as the photographic processes for the reproduction of drawings, &c., in large numbers, were confined to photo-lithography and the simpler methods of phototypography or gillotage and photo-intaglio engraving, all of which were suitable for pure line work only, the reproduction of pictures or shaded drawings received comparatively little attention. By the introduction, however, first of the photo-collotype processes in 1869, which were soon followed by improvements in the half-tone processes of photo-intaglio engraving, and quite recently by the successful production of half-tone phototypographic surface blocks by Meisenbach, Angerer, and others, the reproduction of half-tone work has become almost as easy and as common as line work. All these processes are now very largely taken advantage of for the reproduction of pictures and works of art prepared specially for reproduction, as well as for copies of sketches and photographs from nature required for the general purposes of book, magazine, and newspaper illustration. As a good example of book

illustration by blocks taken from photographs may be cited Dr. Gustave le Bon's work, *Les Civilisations de l'Inde*, published by the well-known house of Firmin Didot, of Paris, which is illustrated with upwards of 300 photo-typographs in the text, from photographs taken by the author in all parts of India, and chiefly of architectural monuments. Though these little pictures are for the most part on a very reduced scale, they reproduce the photographs very perfectly, and render the most delicate details of rich Indian ornament in a manner that would be almost impossible by any process of hand engraving. It is needless to point out the advantages in truth and accuracy such illustrations, taken from the actual photographs, have over the best engravings or lithographs from hand drawings. As examples of the use of these processes for the cheap reproduction of works of art, may be noted the numerous series of photographic reproductions of the best works in the Paris *Salon*—some by photo-typography, others by collotype, and others again of a higher class by photo-engraving. The same with the English *Academy* and *Grosvenor Notes*, both now largely illustrated with half-tone blocks, taken from photographs of the original pictures or from sketches by the artists themselves.

It will readily be understood what an immense advantage these new processes offer to artists for reproducing their work in fac-simile just as it leaves their hands, and without any necessity for an intermediate

drawing being made, as has hitherto been necessary, whether the subject was to be lithographed or engraved on copper or on wood. Not only is the reproduction more faithful, but there is an enormous saving in time and labour, which is of importance in these days of living at high-pressure, when the occurrences of one day are utterly forgotten the next, and the world waits for nothing.

As already noticed, there are certain difficulties in reproducing paintings in oil or water-colour by photography which can only be overcome by the use of sensitive plates stained with certain dyes, such as chlorophyll, cyanin blue, eosin, erythrosin and other similar derivatives of fluorescein, which increase the sensitiveness of the bromide of silver to green, yellow, and red, and lessen it for blue, thus producing an effect on the resulting photographs more nearly approaching that given by the picture to the eye, than can be obtained on plates prepared in the ordinary manner. The effect is heightened by allowing the rays from the painting to be copied to pass through a yellow screen before falling on the stained sensitive plates, and in some cases it has been found that the use of a yellow screen alone is sufficient to produce the desired effect. These methods, which have not yet been fully worked out, are at present imperfect, on account of the difficulty there is in rendering any photographic plates sensitive in the proper proportion at the same time to red, blue, and yellow pigments and their

various mixtures, as they appear in oil or water-colour paintings.

The most satisfactory results, therefore, in copying drawings or paintings in half-tone, are obtained from work shaded in monochrome; the writer believes it is the practice with some artists of repute, on the Continent more, perhaps, than in England, to prepare for publication special copies in monochrome of their paintings. It has always been a common practice with the artists of the illustrated papers to prepare their drawings for the wood-engravers in wash, the engraver translating the various tones of the drawing by hatching in lines of varying thicknesses and distances apart.

For copies of paintings, and similar work of a purely artistic character, where it is desirable to retain the effect and texture of an oil painting, oil monochrome is, perhaps, in some ways, more suitable than water colour; but for all ordinary purposes, water monochrome is preferable to oil for photographic reproduction. The dull surface of a water-colour drawing is, in itself, a very great advantage in avoiding troublesome reflections.

The writer has had no experience in the reproduction of oil monochromes, and the subject is, moreover, somewhat foreign to the special objects of this work. It is, however, fully treated on in Hamerton's *Graphic Arts*, which may be referred to by those desiring fuller information.

Water-colour monochromes are usually executed in Indian ink, sepia, or bistre, neutral tint or other sub-neutral compound bluish or purple greys, or in pure neutral grey formed by mixtures of black and white.

The paper used for monochrome drawings for reproduction should be smooth and white, especially for small work to be reproduced to scale. In large drawings for reduction a certain amount of grain in the paper will not be so objectionable. If tinted paper be used, it should be of a bluish rather than a yellowish tinge, otherwise the resulting photographic copy will not show sufficient contrast between the ground and half-tones of the subject, and the general effect will be altered. If necessary to produce a softer effect, the ground of the copy may have a tint printed from stone, or a ruled tint may be added by transfer or by engraving with the machine.

With regard to the most suitable pigment to be employed for monochrome drawings, the author has scarcely sufficient experience to make any recommendation. Indian ink is most commonly used for shading maps and technical drawings, and as these are generally drawn in black, is most suitable. A little yellow, burnt sienna, or sepia, may be added to take off any blueness and increase the contrast between the lightest shades of the drawing and the white paper.

The great advantage, according to Hamerton, in the use of Indian ink for monochrome drawings, is the

perfect purity and equality with which it yields shades of all intensities from the lightest to the darkest. Owing to the exceeding divisibility in water of the particles of carbon, they tint a large quantity of water equally, and the mixture has more the properties of a solution of a dye than of an emulsion containing particles of insoluble pigment held in suspension. The most delicate distinctions of shade can thus be shown with Indian ink. Another great advantage of Indian ink is its indelibility when applied to paper, so that the outline and first shades of a drawing are not disturbed by subsequent washes.

For the ordinary run of shaded drawings and sketches, Indian ink is, in some ways, not so convenient to use as sepia or neutral tint, which can be purchased as moist colours in pans or tubes, and require no rubbing down.

The same writer says of sepia: "Although it is a brown and not a black, it is remarkable for the intense depths of its darks, which get down to a note lower than many shades of colourless grey which are commonly called black. This, of course, is a great convenience, as it gives the artist a fine range or gamut. By using tube sepia he can put very intense darks in their full strength wherever he requires them." He adds, with reference to objections that sepia is irregular in tint and not easily divisible into a minute scale of shades, that with sepia, as it is prepared in the

present day, he does not perceive that there is any greater difficulty in washes and shades than there is with Indian ink.

Sepia drawings reproduce very well; the delicate shades give a good contrast with the white paper. On all accounts, perhaps, sepia is the best pigment for the purpose.

Mr. Trueman Wood, in his *Modern Methods of Illustrating Books*, strongly recommends a mixture of lamp-black and Chinese white. This mixture gives a fine range of pearly greys, and works very smoothly and evenly. The deepest shadows may be obtained by keeping the pure black in reserve, a little burnt sienna or gamboge may be added to take off any slight tendency to blueness and increase the vigour of the shadows.

The writer is indebted to Col. H. C. B. Tanner, of the Survey of India, for the following suggestions on the subject of monochrome painting in oils or water.

For water-colour :—Use the paper of A. W. Hunt, of Kent. It has excellent grain, and though exposed to damp and dry air for many years, it hardly ever goes bad either by becoming spotty or by turning brown. No other paper that Col. Tanner is acquainted with has these advantages. For colour use Indian ink and indigo, so mixed as to give a perfectly neutral shade of black. Sometimes a metallic looking scum may be observed on Indian ink when rubbed for use. Strips

of dry paper passed over the solution will remove it. Unless got rid of, this scum often causes indelible stains on the lighter parts of the picture.

Some kinds of liquid Indian ink give excellent results, and with indigo other kinds mottle. The liquid, before required for use, should be poured out on to the palette or plate and allowed to dry.

For oil-colour:—Use either canvas, prepared oil-paper, or Hunt's drawing-paper, with Chinese white and blue-black. Turpentine is the best medium. Oil, megilp, &c., stain the paper yellow, which colour shows through after some months.

If the paper is too porous, wash it over with the solution of isinglass or gelatine and alum already recommended for restoring damaged drawing paper.

Damaged water-colour monochromes may be converted into oil monochromes by painting over the detail carefully after first washing with the gelatine preparation, if necessary.

Sketches or shaded drawings in neutral tint reproduce fairly well, but the bluish tendency of the pigment makes it somewhat difficult to preserve the lighter tints with sufficient contrast. A little burnt sienna would probably be an advantageous addition. In reproducing drawings of this kind with a blue tint, it has been found advisable to cover them with a glass coated with collodion, containing a red dye, such as eosin.

Monochrome drawings should, as a rule, be executed

throughout in one colour, black, brown, or neutral grey, formed by mixing black and white. By doing so, it will be easy to judge correctly the effect when photographed.

Coloured drawings and sketches should be kept as nearly as possible in one key, recollecting that yellow tints will reproduce much darker and mixed grey tints containing blue lighter than they appear. It is a common practice to make sketches in sepia and French blue or cobalt, but, unless great care be taken, the effect of the photographed copy will be quite different to that of the original.

Drawings in which there is a combination of pen-work and brush-shading, with large spaces of white ground, offer peculiar difficulties in reproduction, and require great care and skill on the part of the photographer to get the ground of the negative dense enough to give a perfectly clean impression in the white parts, and at the same time to keep the lines clear and give the faintest tints of the shading their proper value. There is always a tendency for the shading to be too dark in the shadows, even though the darkest shades of tint may be much weaker in tone than the lines or writing; on the other hand, the lightest shades are apt to be destroyed by the intensification necessary to obtain clear whites in the ground. It is generally advisable to intensify the photographic negative only just sufficiently to preserve the lightest shades, and then to carefully strengthen the pure white parts of

the ground with black lead applied with a stump, or to stop them out with opaque pigment varnish. The too great transparency of the deepest shadows may also be lowered with the black lead and stump.

It might therefore be advisable, in preparing shaded drawings specially for photographic reproduction, to make the lightest shades slightly darker than they should be, and the darkest rather lighter. This method, the writer believes, is followed by professional draughtsmen accustomed to this kind of work.

The writer cannot speak from experience, but it is probable that the new style of tempera or pastel painting now in vogue would be peculiarly adapted for bold, effective work in monochrome, suitable for reduction. The method seems to combine the distinctive advantages of oil and water-colour painting, and the dull surface of the drawings is all that can be desired.

CHAPTER VII

HALF-TONE DRAWINGS IN PENCIL, CHALK, ETC., ON PLAIN AND GRAINED PAPERS.

THOUGH the various methods of drawing in black and white, with lead-pencil or chalk, on plain or grained paper, are not specially applicable to technical drawings, except perhaps for the shading of the mountain features on certain classes of maps, this work would not be complete without notice of them. The grained papers offer several advantages for the speedy preparation of sketches and drawings to be reproduced by the photo-typographic processes, and are now used to a very considerable extent for book illustration.

DRAWINGS IN LEAD-PENCIL.

Although the lead-pencil is one of the commonest and most convenient means of making drawings and sketches, pencil drawing, which reached its highest development as an art in the days of Mr. J. D. Harding, has since his death declined. This decline is chiefly attributable to the increasing use of colour for all sketching work, but may also be partly due to the

more extensive adoption of pen-and-ink drawing as better adapted for photographic reproduction by the ordinary and cheaper photo-lithographic and phototypographic processes.

Pale pencil drawings are very difficult to reproduce well; but, provided the lines are fairly strong, pencil drawings on good, white, smooth paper can be reproduced with admirable effect by the photo-collotype and photo-engraving processes. As an example, may be mentioned the beautiful drawings in A. Hendschel's *Skizzenbuch*, which have been reproduced in photo-collotype, or, as it is called in Germany, "Lichtdruck," by Messrs. Martin Rommel of Stuttgart. Except that the darkest lines are blacker than pencil lines usually are, it would be difficult to recognise that these prints are not the actual pencil drawings, so faithfully have they reproduced. Excellent photo-collotype reproductions of architectural drawings in pencil have also been made in England by the Heliotype and Autotype Companies.

Recent improvements in half-tone photo-typography and the use of grained papers offer facilities for the cheap and speedy reproduction of pencil drawings, though not in *fac-simile*, which were wanting when the use of photo-typography was confined to pure line work. With these new facilities for photographic reproduction, it is possible that the lead-pencil may again come into favour as a convenient and effective means of producing drawings and sketches for publication.

The lead-pencil is most suitable for small drawings

with delicate details, as, for instance, architectural sketches or drawings for scientific purposes. It has the advantage over other methods of drawing that very varied effects in delineation of texture and light and shade can be obtained with it with the most perfect freedom in handling and ease in working. Used with a fine hard point it is suitable for the most delicate line work. With broader, softer, and darker points, cut round or square, it will produce clear distinct lines of varying thicknesses and depths of tint according to the hardness or softness of the point used and the amount of pressure applied. By working the point so as to fill the interstices between the lines, shades may be produced of any desired intensity within the range of the point used. Worked with a stump it gives a good range of smooth grey continuous shades without lines, like washes of colour, which may be used alone or in combination with lines, in the same way as pen-and-ink drawings with auxiliary washes. The only other drawing tool that can be used alone both for fine lines and for tint is the brush, but it is much more difficult to manipulate.

Lead-pencil drawing may also be very effectively combined with washes of Indian ink or sepia, or on tinted papers with washes of one or two tints, such as sepia or Indian ink, with high lights in Chinese white. Blue is often used in addition, but is not desirable on drawings for photographic reproduction, as explained before.

The lead-pencil is, however, wanting in power and depth of tone. Its deepest shades are pale when com-

pared with black chalk and inks or pigment blacks. Its shine is also objectionable, both from an artistic point of view and because it is likely to cause a further lowering of the depth of the darkest lines, and indistinctness of detail when photographed.

Owing to these defects, although pencil drawings can be very effectively reproduced by photography if properly drawn for the purpose, they offer difficulties to the photographer, which are greatly increased if the drawings be made, as is often the case, on rough or tinted papers of an unsuitable colour, or with hard, pale pencils.

Pencil drawings for reproduction should therefore be drawn with pencils of medium strength, so that the lightest lines may reproduce, and be shaded, if necessary, with darker pencils.

The smoothest, white, unglazed paper should be used. In some cases more artistic effects in drawing may perhaps be obtained on paper with a moderate grain, but the light pencil lines being so pale will be liable to be overpowered by the reproduction of the grain of the paper, and the result will be coarse. Bristol boards are very suitable for pencil drawings, but the best results are obtained on paper or cards faced with a mat-enamelled surface, such as is used for photo-collotype printing. On this surface the pencil lines appear much darker and sharper.

Tinted papers or cards should, as a rule, be avoided, except for special effects, because, unless great care is exercised in the selection of a suitable

tint, there may be difficulty in obtaining the requisite contrast between the finest lines and the ground, and the picture will look flat and heavy, not having the contrast of colour of the original. If a tinted ground is necessary, it should be bluish rather than greenish or yellowish. If desired, the copies can be printed on tinted paper; or lithographic tints, with or without high lights in white, can be printed on them.

It will generally be advisable to make pencil drawings in clear distinct strokes, so that when reproduced the drawing may have its own spaces to break the continuity of the shading, and not have to be broken up by a grain which is not natural to pencil drawings. If, however, the drawing is required to be reproduced by photo-typography for letterpress printing, it should be made on grained paper with a soft pencil, without stumping, and in strongish lines.

It is advisable always to fix pencil drawings intended for reproduction, in order to prevent their being rubbed or injured in transit. This may be done with a solution of isinglass in hot water, with skimmed milk or preferably with gum water—about one ounce of gum to a quart of water. The fixing agent may be applied either by careful brushing with a flat camel's-hair brush, or by pouring it into a dish and carefully floating the drawing face downwards on its surface.

These methods are apt, however, to degrade the lights by washing over them part of the lead off the dark parts. A "spray producer" is the best thing for

fixing drawings in pencil, chalk, or charcoal, and a good fixing solution to be used with it is one part of gum-mastic to seven parts of methylated spirits of wine.

Owing to the fact of the lines of a pencil drawing being of different intensities, such drawings are best reproduced by the photo-collotype or photo-engraving processes, which will yield lines of different intensities. In these processes the necessary grain is so slight that even pencil drawings shaded with the stump can very well be reproduced with little loss of delicacy of gradation. With photo-lithography or photo-typography, all the lines or dots forming the print are of the same intensity of blackness, and, therefore, prints of pencil drawings reproduced by these processes appear much darker and coarser than the originals.

The platinotype and some of the new processes of development printing on gelatino-argentic bromide papers, which all yield an image of a delicate dark bluish-grey or brownish tint, are also very suitable for the reproduction of pencil drawings when not required in large numbers.

Recent experience in reproducing some very delicate pencil drawings of insects, &c., in the Survey of India Office, Calcutta, has shown that better results are obtained by taking the negatives on gelatine dry plates instead of by the wet collodion process. The lighter shades are better preserved, while the shadows are not unduly darkened. The same observation will probably apply to half-tone work generally.

DRAWINGS IN BLACK CHALK.

Black chalk is very much darker than lead-pencil, and lines drawn with it are free from shine. It also gives a much more extensive range of tones with the stump. It has not, however, the same power of delicate definition, and therefore is best suited for large drawings in which effect is more important than accuracy and delicacy of detail. The very want of definiteness in the chalk line is its great charm.

At the same time, as is shown by lithographic drawings, which are worked very carefully and deliberately and with a fine point, chalk is capable of producing very delicate shaded drawings, with a considerable range of tone from a deep velvety black to the most delicate light shades, and an almost inimitable power of rendering texture which makes it peculiarly valuable for scientific drawings.

Red chalk is often used, but chiefly for portraits or figure subjects, as giving a warmer and more flesh-like tone than black chalk; but it is not nearly so powerful in effect or range of tone. It is also used in combination with black chalk, and, on tinted papers, with white chalk in addition.

Black or red chalk drawings in outline, or shaded in distinct lines on white paper, can be reproduced by any of the ordinary photo-lithographic or photo-typographic processes, though with some sacrifice of deli-

cacy. If shaded with the stump, the photo-collotype or photo-engraving processes are more suitable.

Black chalk drawings are often made on grey paper with high lights in white chalk. Such drawings, as well as those in which the effect of the chalk is heightened with washes of Indian ink, must be reproduced in the same way as half-tone monochromes by photo-collotype or photo-engraving, or by the half-tone photo-typographic processes.

As much of the beauty of chalk drawing is due to the lines being broken or granular, and not continuous, it is necessary to use papers with a slightly granular surface for this kind of drawing, instead of the smooth and faced papers used for pencil and pen-and-ink drawings. A certain amount of grain is also required because the chalk has no hold or "bite" on smooth paper. The surface should not, however, be too rough, otherwise the effect will be coarse from the reproduction of the roughness of the paper.

Special papers are prepared for chalk drawing with different kinds of grain impressed on the surface from engraved metal plates. The grain is, however, as a rule, too regular and mechanical in appearance, and not so agreeable as the natural grain of paper.

CHARCOAL DRAWINGS.

Of late years, especially in France, charcoal or *fusain* drawing has taken a very high place among the graphic arts. Charcoal drawings are very well adapted for multi-

plication by photography, as testified by the beautiful reproduction of drawings of this class by Allongé, Appian, Lalanne and other masters of the art, to be found in the print shops in Paris. Being generally drawn on a large scale, they readily stand a certain amount of reduction.

Charcoal has many admirable qualities, in the transparency and delicacy of its light effects and the dark velvety richness of its shadows. It is readily applied to the paper, and as easily removed, so that a drawing can be worked up and alterations made to any extent. Used in different ways and worked with different kinds of stumps, or even with the finger, a great variety of effects may be produced; unskilfully used, it has a tendency to heaviness.

Charcoal is best suited for drawings on a large scale, because it has less power even than chalk of rendering delicate details, and its peculiar forte lies in the certainty and convenience with which it can be used as a means of representing chiaro-oscuro by shading alone without the aid of lines—in fact, as a mode of dry painting.

Charcoal drawings require to be fixed with a weak solution of shellac in spirit of wine—about the colour of pale sherry—applied with a spray machine. In some cases the varnish is better applied to the back of the drawing. If the slight yellow tint given by the shellac is objectionable the solution of mastic given before will be preferable.

When greater finish is required than can be obtained

from charcoal alone, the drawings may be worked up, *after* fixing, with Indian ink.

The charcoal generally used is made from the wood of the spindle tree (*fusanus euonymus*), hence the term *fusain*. It is hard and close-grained.

For reproduction, charcoal drawings should be on white paper, and may be reproduced without difficulty by the photo-collotype or photo-engraving processes. Provided the grain of the lines is fairly open, some of the more delicate photo-lithographic processes would also be suitable. In these processes the transfer prints are obtained by moistening the sensitive paper bearing the photographic image, and bringing up the design with smooth rollers charged with lithographic transfer ink, in the same way as is done in inking up a collotype plate for printing. By this means the most delicate parts of the design are preserved and are not liable to be injured, as in the processes in which the surface is washed clean with warm water and a sponge.

The artistic aspects of pencil, chalk, and charcoal drawing have been fully treated on in Hamerton's *Graphic Arts*, to which I am indebted for much of the information given above; reference to it may well be made by those interested in the subject.

THE AIR-BRUSH.

Within the last few years a very valuable addition has been made to the artistic resources of the draughtsman in black and white, by the invention, by Mr. L. Walkup

of Rockford, Illinois, U.S.A., of the air-brush, an ingenious machine by which ink or any fluid pigment is thrown in a state of fine spray on to paper, card, lithographic stone, or any other suitable surface. The image thus produced consists of a series of fine dots of ink, closer together and larger in size in the dark parts, where the instrument is brought closer to the paper, than in the lighter parts, where it is used at a greater distance.

The instrument bears no resemblance to anything hitherto in use for drawing or painting purposes, but, as with all other methods of drawing, the art is not in the tool, but in the hands and head that guide it; and in the hands of a skilful draughtsman accustomed to its use the air-brush is capable of producing the most exquisitely soft and delicate gradation of shade, from rich, deep shadows to almost imperceptibly fine light tints, with a peculiarly soft and melting effect due to its diffusive qualities and quite unobtainable by chalk drawing. The shadows, however deep, are transparent, being illuminated by minute interstices. As may be supposed, it is not capable of giving accurate delineation of minute detail beyond what can be produced by shade, but the drawings can be worked up and finished, as desired, with pen, chalk, or brush.

Very delicate colour work can also be done with the instrument—there being no danger of washing up—one colour passing over another without the slightest disturbance.

It is likewise very useful for colouring or shading

tracings on vellum cloth, because there is no tendency to cause the cloth to crinkle by saturation with moisture or to spoil its surface.

The great feature of the air-brush is the extreme rapidity with which the most finished effects are produced. The writer has seen a piece of delicate shaded work done in a couple of minutes that would have taken a good draughtsman half-an-hour or so to do by hand.

The instrument, which is held in the right hand, is connected by a flexible tube with an air-pump worked by the artist, sitting at a special easel, by means of a treadle. A current of air is thus forced through the instrument and issues through a fine nozzle, just above the free end of a fine needle or bristle which lies in a sort of spoon containing a supply of ink. The ink, passing along the needle, is caught by the downward current of air and thrown on the paper as a fine spray. By bringing the needle point close to the paper and regulating the supply of air by means of a valve worked with the thumb, dark lines or shades may be put in, the supply of ink being concentrated : by removing the point from the paper, the spray becomes more diffused and the tints produced gradually become lighter in proportion to the distance of the point.

The instrument is admirably adapted for producing drawings in Indian ink on smooth white paper for photographic reproduction, which may be treated in the same way as ordinary monochrome drawings.

A special advantage of this method of drawing for photographic reproduction is, that a fine stippled effect may be produced upon a perfectly smooth surface, whereas chalk and charcoal, with which the same effects can be most nearly reproduced, require a more or less rough surface to give the necessary "bite" or tooth to hold the chalk, and in the subsequent reproduction this roughness is liable to destroy the delicacy of the finer parts of the copy.

The air-brush has been introduced into the Ordnance Survey Office, Southampton, for the hill shading of maps, and appears likely to be very useful for that purpose, though it requires a highly skilled draughtsman to work it to best effect. Such drawings can be successfully reproduced by photo-collotype, or better by the etching processes of heliogravure.

DRAWINGS ON GRAINED PAPERS.

In preparing pictorial drawings and vignettes to be reproduced by photo-typographic methods and printed with type—like woodcuts—considerable use is now made of papers prepared with grained surfaces of different kinds, and intended to be drawn upon with pencil, chalk, or crayon. These papers are of two distinct kinds:—

(I.) White, faced papers impressed with a grain like a lithographic-stone, or with mechanically ruled dots or parallel lines crossing at right angles, forming

grained surfaces of varying degrees of fineness or coarseness. Drawings on these papers are executed entirely with lead-pencil, using a soft pencil in firm, strong strokes, or black crayon, and, if necessary, may be finished in the darker parts with Indian ink or lampblack, either by means of pen or brush. Plain grained papers are readily obtainable of English, French, and Austrian manufacture, and the methods of using them require no special notice.

(II.) Papers with a thick, white, enamelled surface, upon which, in the first instance, are printed in black, ruled "tints" composed of parallel lines, which may be continuous or broken into dots of different thicknesses and distances apart. The paper is then impressed with a series of parallel furrows and ridges running at right angles to the printed lines. With these "tinted" papers the greater part of the effect is produced by means of plain or toothed scrapers, which cut into the enamelled surface and break up the printed lines into broken lines running at right angles to them, forming a series of gradually lightening tints as more and more of the enamelled surface is scraped away, until finally, when all traces of the printed lines have been removed, white spaces forming the high lights of the picture are obtained. The outline and other details are drawn in with pen, lead-pencil, chalk, or brush.

The regular mechanical grain has a somewhat unpleasant effect, but it is suitable for the requirements

of printing blocks to be printed in the letterpress machine, and is also a very great saving of labour to the draughtsman.

The best descriptions of these tinted grained papers are manufactured by the patentees, Messrs. Angerer and Goëschl of Vienna, who give the following instructions for their use:—

The design is traced on the prepared paper either with *blue* tracing tissue, prepared by rubbing dry powder blue over tissue paper, or it may be *lightly* sketched in with a hard pencil. Red tracing paper should not be used.

For drawing with the pen, Indian ink or lamp-black may be used, the ink being sufficiently thick to produce fine black lines. With the brush, black oil colour or fine printing ink, thinned with benzine or with a mixture of benzine and turpentine, so as to preserve a medium consistence: too thin, it will be liable to spread; too thick, it will take too long to dry.

As the scale of the drawing is usually greater than the copy should be, the colour should be mixed thick and strong.

The best way of mixing the colour is to take a small oval porcelain dish and tilt it up with a wedge at one end into a sloping position. In the upper part a small quantity of the colour is placed, and in the lower the mixture of benzine and turpentine; the centre of the plate serves as a palette.

The outlines are drawn with a fine sable brush,

which should be cut in the manner before described. The medium shades of black are worked up with lithographic chalk or with a soft black lead-pencil. Conté crayon is not recommended, because it is easily rubbed and pure lines cannot be obtained with it.

* By drawing on the tinted paper with chalk or lead-pencil, a variety of shades of lines or dots may be produced.

On the drawing thus prepared the most varied effects of light may be obtained by means of the scraping knife.

Care must be taken that the tone of the drawing is as black as possible, seeing that in printing the printing ink will not give the same full effect as is obtained by the brush and colour.

The same remark applies to the whites, because the drawing paper is much whiter than printing paper.

A certain exaggeration in the shades is therefore necessary to obtain the desired effect, otherwise the reproduction will appear more or less flat.

It is important to know how to use the scraping knife. The handle is placed between the third and fourth fingers, or between the latter and the little finger, according as it is to scrape in lines or open spaces. The thumb is pressed on the blade, as near the point as possible, in order to overcome its flexibility: ~~the~~ forefinger and middle finger press the instrument against the thumb. The knife should not

be passed vertically over the paper, but with the edge forward towards the draughtsman. In this position the knife cuts into the surface like a plane blade. Held in any other way, the knife does not clear off the surface completely and soon becomes blunt.

For sharpening the scrapers, the best Turkey oil-stones should be used, and care should be taken that the original form of the scraper is preserved, and to see that it lies flat on the surface during sharpening. It is needless to say, that the toothed scrapers should not be sharpened on the ribbed sides.

By scraping with the flat scraper, points are developed in place of the lines, and by further scraping, these points disappear in the white, and so produce a range of shades from pure white up to the most intense black.

Further, by treating a full shaded black surface with the flat knife, a tint of lines is produced in the opposite direction to those printed on the paper, and this is often a great advantage.

By using the toothed scraper other arrangements of lines may be produced at will. The artist alone can judge where and how these two instruments should be employed.

Should the original printed tint be only suitable for part of a picture, the other parts can be covered either with white paper or with paper of other tints, which may easily be attached at the edges with wafers or smooth glue. The application of paste or gum all over

the surface of the paper would cause distortion and injure the photographic reproduction.

These half-tone papers should not be rolled, but kept flat, and if sent through the post, carefully protected from creasing with thin boards or stiff cards.

The rule that in drawings for reduction the details should be drawn with special reference to the scale of reduction, applies equally to these drawings, and it is evident that the use of the impressed and tinted half-tone papers is limited to cases where only slight reduction is required, on account of the closeness of the lines. For drawings requiring reduction, the most open tints must be used. The tendency of work to close up and darken in reduction must also be borne in mind.

Chalk drawings are easily executed on the grained papers with lithographic chalk, very light pressure being used, and the darker shades brought out by repeated working over the parts.

DAY'S SHADING MEDIUMS.

Effects similar to those produced by drawings on the grained and tinted half-tone papers are obtainable, in even greater variety, by the use of Day's shading mediums. These consist of thin transparent sheets of gelatine which have lines or dots, &c., in relief on one side, while on the other they are quite smooth. The transparency of these films is a very valuable feature,

because the artist can see the whole of the drawing below them and know exactly what he is doing. The lines on the gelatine being in relief can be readily inked up with printing ink by means of an ordinary letterpress roller, and the impression of them transferred by means of a burnisher to parts of the drawing where they are required.

The films are best used in a special frame furnished by the patentees, which enables the films to be exactly adjusted in any position and brought back to it, if required, after a second inking of the tint. It also permits a slight shifting of the lines if it is required to thicken them. Dots may be thickened in the same way, and various patterns of grain can be produced from one plate.

These films, being to a considerable extent elastic, admit of varying effects being produced in the transferring by more or less pressure with the burnisher.

A great variety of tints may also be made by combining the different films.

The films are chiefly for the use of lithographers in preparing tint and colour stones for chromo-lithography; but they are also applicable to black and white drawings on paper.

CHAPTER VIII.

CLEANING AND BLEACHING OF DISCOLOURED DRAWINGS AND ENGRAVINGS.

WHEN drawings are prepared specially for reproduction, there need be no difficulty in taking all the precautions necessary to keep them clean and free from spots or stains which would give trouble in reproduction. Even with all precautions, it is not always possible to prevent drawings getting dirtied in hot and dusty places, or being stained by accident.

Again, it often happens that reproductions are required from old manuscript drawings or prints that have become faded and yellow with age, and it is an advantage to be able to clean them so that they may be suitable for reproduction, in the cheapest and simplest manner, by photo-lithography or the photo-block processes.

Yellow stains or other objectionable spots should be carefully covered over in the spaces between the lines with Chinese white.

Any lines or details not required may be covered over in the same way. When possible, weak faint lines should be carefully strengthened with a pen and

Indian ink. A soft black-lead-pencil is also useful for strengthening lines.

Old engravings and lithographs may be bleached by immersing them in a solution of chloride of lime, one part of *liquor calcis chloratæ* in 39 parts of water, or *eau de javelle* (1 to 10 or 15 of water), till they are quite white, then soaking them in water for some hours, after which they may be treated with a weak solution of hyposulphite of soda to remove all traces of chloride, and are finally well rinsed with clean water.

Eau de javelle may be prepared by taking 4 lbs. of bicarbonate of soda, and boiling it in a kettle with one gallon of water for about fifteen minutes, and then stirring in 1 lb. of chloride of lime, avoiding lumps. When cold the liquid is ready for use.

Another plan is to sprinkle finely-powdered salt all over the engraving, then squeeze lemon juice upon the salt so as to dissolve most of it. Boiling water is next poured on till the salt and lemon juice are washed off. The surface will then be quite clean and free from stains. The engraving should be allowed to dry without heat and gradually, on a board or other smooth surface (*Spon*). A short soaking with very dilute hydrochloric acid (1 to 20) or acetic acid, followed by plentiful washing, will clear up a print very much.

Mr. W. Brooks recommends the use of "Holmes' Ozone Bleach" as superior to any chlorine bleaching, and not so liable to injure the original by traces of

chlorine remaining in the fibres of the paper. The best strength is about one part to ten of water, and the engravings may be left in it from half-an-hour to four hours if very brown. With a stronger solution the time would be somewhat less. After all the stains are removed, the bleach is poured off, and the print well washed in several changes of water, or in running water for about two hours, then blotted off and dried.

Grease stains, if fresh, may be removed with chloroform, benzine, or ether, or with a weak alkaline solution of caustic potash or its carbonate. Old stains can be removed with a more or less strong solution of potash applied at the back of the subject.

Iron moulds and ink spots may be taken out with a solution of oxalic acid or salts of sorrel.

Surface markings on prints, drawings, and engravings may best be removed by gentle rubbing with stale bread.

Before reproducing oil-paintings, it is advisable to clean the surface and brighten up the colours by going over the painting with a soft cloth or sponge dipped in olive oil, glycerine, or sugar dissolved in the white of egg; beer has also been recommended for this purpose.

Orthochromatic plates are a great resource in copying old stained prints and oil-paintings.

ADDENDUM.

ON ENLARGING.

IN his new work, "Pen Drawing and Pen Draughtsmen," Mr. Pennell remarks that sometimes better results in the reproduction of drawings are obtained by enlarging them, though this is in opposition to the usual rule that drawings are improved by reduction.

It is so seldom that the writer has occasion to resort to enlarging, that the point was only casually noticed in preparing the text, and he is glad that Mr. Pennell's remark has reminded him of it.

There is no doubt that for reproducing engravings or pen drawings, in which the lines are very fine and close together, a slight enlargement is an improvement, if the increase of size is permissible; and occasions do arise when enlargement can be resorted to with considerable advantage if the original is suitable.

During one of the recent European wars, the only plan of a certain fortified city available in Calcutta was a small engraving inset in a sheet of an atlas. It was too finely engraved to be of any use if reproduced on the same scale, but by enlarging it to twice or three times the original scale a very useful little map was made, and the lines were by no means so coarse as might have been expected.

Engraved and clean-cut lines will of course stand enlargement much better than lines drawn with a pen, which are always liable to be more or less ragged; but if the paper is smooth, and the pen-drawn lines fairly firm, sharp, and clean, very good enlargements could be made if desirable, and in some cases with advantage. Line-work drawn with the brush would probably enlarge much better than pen-work, the edges of such lines being sharper.

It must be remembered, however, that by enlargement all defects are exaggerated and made more prominent, whereas the reverse takes place in reducing, and hence the usual rule that drawings should be made for reduction seems the safest to follow. Optical difficulties and others connected with the lighting of the original have also to be contended with. Enlargement should be looked upon as a valuable resource to be used on special occasions.

In reproducing the minute details of scientific drawings, enlargements would often be extremely useful.

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